THE IMPACT OF CUSTOMER SPECIFIC REQUIREMENTS ON SUPPLY CHAIN MANAGEMENT

A Masters dissertation

by

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DECLARATION:

I, Hubert Ignatius Percy Conceivious, hereby declare that the contents of this dissertation submitted for the degree Magister Technologiae: Quality at the Cape Peninsula University of Technology, present my own original unaided work, and that this dissertation has not previously been submitted to any other institution of higher education towards any qualification. I further declare that all sources cited or quoted are indicated and acknowledged by means of a comprehensive list of references. Furthermore, it presents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

Signed **Date**

DEDICATION

This study is dedicated to my wife Carmen and my children Nathan and Micah for their love and support.

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ABSTRACT

The Catalytic Converter Industry (CCI), forms part of the component supply chain in the motor industry. The CCI is made up of a plethora of different suppliers, however for the purpose of this study, the focus will be on three of the five main suppliers, namely the 'monolith substrate manufacturers', the 'coaters', and the 'canners'. The latter suppliers supply directly to the car manufacturers, also commonly referred to as the Original Equipment Manufacturers (OEM), and are known as first tier suppliers. Some OEM's exercise control over the entire supply chain. The control is exercised through various 'customer requirements' and 'customer specific requirements'.

Customer specific requirements influence the Quality Management System (QMS) of a supplier. Most OEM's require that strategic suppliers must be ISO/TS 16949:2002 certified. ISO/TS16949:2002 refers to an internationally recognised specification, specifically adopted for the motor industry, and dictates the certification requirements that an organisation's QMS must adhere to. The specification also makes provision for additional requirements that could be specified by the customer. In this instance, the customer is the OEM, in terms of which additional requirements can be specified over and above the certification requirements.

For organisations manufacturing generic components for the various motor manufacturers, customer specific requirements add to the complexity of activities related to quality management systems. Applying an array of methods to minimise the risk of sending defective products to the customer by building each customer's specific requirements into the quality management system, can lead to confusion and make work difficult to execute. To mitigate the complexity, the quality management systems should be simplified to ensure that the quality management system is entrenched and adds value to the organisations' activities.

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GLOSSARY OF TERMS

Catalytic Converter	A reaction chamber typically containing a finely divided platinum-iridium catalyst into which exhaust gases from an automotive engine are passed together with excess air so that carbon monoxide and hydrocarbon pollutants are oxidised to carbon dioxide and water.
Customer Specific Requirements (CSR)	Specific customer requirements include product descriptions, material content, material specifications, vendor selection, shipping, price and other data specific to the product being purchased. They are generally communicated to the organisation through the Request For Quote (RFQ) process. Customers may provide this information via data or specification sheets and prints.
Request for quotation (RFQ)	A document used to solicit price and delivery quotations that meet minimum quality specifications for a specific quantity of specific goods and/or services. RFQ are usually not advertised publicly, and are used commonly for (1) standard, off-the-shelf items, (2) items built to known specifications, (3) items required in small quantities, or (4) items whose purchase price falls below sealed-bidding threshold. Suppliers respond to a RFQ with firm quotations, and generally the lowest-priced quotation is awarded the contract. (Anonymous1, 2009: **Online**)

ISO/TS 16949	This Technical Specification, in conjunction with 'ISO 9001', defines the quality management system requirements for the design and development, production and, when relevant, installation and service of automotive-related products. This Technical Specification is applicable to sites of the organisation where customer-specified parts, for production and/or service, are manufactured. Supporting functions, whether on-site or remote (such as design centers, corporate headquarters and distribution centers), form part of the site audit as they support the site, but cannot obtain stand-alone certification to this Technical Specification. This Technical Specification can be applied throughout the automotive supply chain. (Anonymous 2, 2009: **Online**)
Quality Management system	Means the combination of processes used to ensure that the degree of excellence specified is achieved. (Anonymous 3, 2009: **Online**)
Supply chain	Supply Chain has emerged as an important factor in creating value for companies wanting to reduce costs, increase asset productivity and improve customer relationships. By combining innovative strategies with practical know-how.
AVSQ *Associazione nazionale dei Valutatori di Sistemi Qualità (Italy)*	ANFIA, Italy's National Association of Car-Building Industries, created AVSQ (translated as the Association of Quality System

	Evaluators) in 1994 to serve as the country's automotive quality requirement, a status it achieved in 1996. (Anonymous 4,2009: **Online**)
EAQF	Published in 1994, EAQF is an ISO 9001-based French automotive requirement that, when translated into English, stands for evaluation, aptitude, quality and supplier. EAQF is used by Citron, Fiat, Peugeot S.A. and Renault, and administered by the Groupe d'Etude Sur la Certification Automobile (GECA).
VDA *Verband der Automobilindustrie*	VDA 6.1 is the German automotive industry's quality requirement. Published by the Association of the German Automobile Industry (Verband der Automobilindustrie), VDA 6.1 consists of two essential parts: management responsibilities and business strategy, and product and process requirements.
Supplier Technical assistant (STA)	Supplier Technical Assistant or Engineer is a OEM representative responsible to assure that suppliers conform to the OEM's requirement.
Supplier Quality Engineer (SQE)	Supplier Quality Engineer is a OEM representative responsible to assure that suppliers conform to the OEM's requirement.

CHAPTER 1: SCOPE OF THE RESEARCH

1.1 INTRODUCTION AND MOTIVATION

In the automotive industry the Original Equipment Manufacturer (OEM's) like Ford, General Motors (GM) Volkswagen (VW), etc. selects the supply chain or nominates a first tier supplier who in turn select the lower tier suppliers in a specific field like the catalytic converter industry. Once the business has been awarded to the individual suppliers in the supply chain, the OEM's customer specific requirements become mandatory to ensure that the required service and quality levels are adhered to and maintained. However, in the OEM's drive to ensure continual improvement within the supply chain, they more often than not introduce additional requirements over and above the agreed Request For Business (RFQ). These additional requirements impact on the ruling quality management system and in most cases, have cost implications. Indirectly, these additional requirements could reduce the profitability of an organisation and impact on production.

The OEM's objectives are driven by maximum output at reduced cost. Costs reduction audits are conducted and organisations are encouraged to introduce new or additional management systems to maximise efficiency, irrespective the nature of the business. In this research study the effectiveness of mandatory requirements that are introduced after the business has been awarded will be evaluated. This calls for the focus to be centered on the impact on quality management systems and other continual work place improvement methodologies implemented by suppliers. Furthermore, in this dissertation the cost of quality will be reviewed and it will be determined if additional mandatory requirements increase profitability, or alternatively, reduce profitability through cost reduction initiatives from the OEM's.

1.2 BACKGROUND TO THE RESEARCH PROBLEM

For organisations who manufacture generic components for the various motor manufacturers, customer specific requirements add to the complexity of activities related to quality management systems. Applying a plethora of methods to minimise the risk of sending defect products to the customer by building each customer's

specific requirements into the Quality Management System (QMS), can lead to complexity of the supply chain. The QMS should be a system so designed to ensure that quality is entrenched and add value to the organisations' activities.

1.3 STATEMENT OF THE RESEARCH PROBLEM

Against the above background the research problem to be researched within the ambit of this dissertation reads as follows: "The requirements of the OEM's to demand that customer specific requirements are built into the QMS of a supplier, leads to complexity in the supply chain".

1.4 THE RESEARCH QUESTION

The research question to be researched within the ambit of this dissertation, reads as follows: "What remedial actions can be formulated, which would facilitate the demand of OEM's for customer specific requirements, while minimising the impact on the supply chain?"

1.5 INVESTIGATIVE (SUB-) QUESTIONS

The investigative questions to be researched in support of the research question reads as follows:

- Which areas of the supply chain are most adversely impacted upon as a result of customer specific requirements?
- Can the impact of continual improvement initiatives driven by the OEM`s on lower tier suppliers reduce cost?
- What is the impact of additional requirements on a supplier after the business has been awarded?
- What impact do compliance and non compliance have on cost and future business allocation?

1.6 PRIMARY RESEARCH OBJECTIVES

The primary research objectives of this dissertation read as follows:

- To formulate remedial actions that would facilitate customer specific requirements while minimising the impact on the supply chain.
- To assess the impact of customer specific requirements on QMS's.
- To establish how the cost of quality indicators are affected.

1.7 THE RESEARCH PROCESS

The research process provides insight into the process of 'how' the research will be conducted from developing the proposal to submitting the dissertation. Remenyi, Williams, Money and Swartz (2002:64-65), explains that the research process as consisting of eight specific phases, which will be applied to this research study. The phases include:

- Reviewing the literature.
- Formalising a research question.
- Establishing the methodology.
- Collecting evidence.
- Analysing the evidence.
- Developing conclusions.
- Understanding the limitations of the research.
- Producing management guidelines or recommendations.

1.8 RESEARCH DESIGN AND METHODOLOGY

Strauss and Corbin (1990:17), defines qualitative research as, "any type of research that produces findings not arrived at by statistical procedures or other means of qualification". In this research study, both quantitative and qualitative research approaches will be used for data collection.

Easterby-Smith, Thorpe and Lowe (2002:133-134), define multiple independent measures, known a triangulation of which there are four categories, namely, theoretical triangulation, data triangulation, investigator triangulation and

methodological triangulation. The latter refers to research where both quantitative and qualitative research approaches are used for data collection. This culminates in diverse data collection techniques that can be used, for example questionnaires, interviews, surveys and field studies. The methodology triangulation is popular in research that pertains to business and management, and information and in information system research.

Galliers and Land (1987:900-901), draw the attention to two tendencies in information system research. The first relates to the primacy of traditional empirical research, which is more suited to the natural science, while the second relates to the tendency to advocate a popular mode of information systems research topic being studied. Citing the results of a study of Vogel and Wentherby (1984), where it was found that 85 percent of published information systems research undertaken by leading US institutions are of the traditional kind, Gallier and Land (1987:900-901), are of the opinion that while such research may be deemed to be academically acceptable and internally consistent, it all too often leads to inconclusive or inapplicable results. Due to the fact that information systems research has often been viewed as residing within the province of technology (Gallier and Land 1987:900-901), the analogy can be drawn that norms would be applicable to 'systems related research', which refers to all disciplines pertaining to management of information technology and 'systems related research'. It is suggested that subjective/argumentative and descriptive approaches be applied to the identified entities as part of a broader focus to the concept of information technology related research, as opposed to the traditional empirical research. Subjective/argumentative and descriptive/interpretative approaches require further explanation:

- The subjective/argumentative approach: Quoting the research of Vogel and Wetherby (1984), this approach is defined by Galliers and Land (1987:901), as: "… creating management information systems research based more on opinion and speculation, than observation".
- The descriptive/interpretation approach" Citing Boland (1985), this approach is defined by Galliers and Land (1987:900), as: "… being in the tradition of phenomenology i.e., concerned with description". The importance of descriptive research is defined by Emory and Cooper (1995:11) as: "The very essence of description is to name the properties of things: you may do more, but you cannot

do less and still have description. The more adequate the description, the greater is the likelihood that the units derived from the description will be useful in subsequent theory building".

1.9 DATA COLLECTION DESIGN AND METHODOLOGY

Within the context of methodological triangulation (Gallier and Land, 1987:900-901), described above, data will be collected using interviews (Cooper and Schindler, 2006:20), and questionnaires (Remenyi *et al.*, 2002:290).

1.10 DATA VALIDITY AND RELIABILITY

According to Collis and Hussey (2003:186), 'validity' is concerned with the extent to which the research findings accurately represents what is happening. More specifically, whether the data is a true picture of what is being studied. According to Cooper and Schindler (2006:318-320), three major forms of validity can be identified, namely 'content validity', 'criterion-related validity' and 'construct validity'.

Reliability (also referred to as 'trustworthiness'), is concerned with the findings of the research (Collis and Hussey, 2003:186). The findings can be said to be reliable if you or anyone else repeated the research and obtained the same results. There are three common ways of estimating the reliability of the responses to questions in questionnaires or interviews, namely:

- Test re-tests method, which will be applied to this research study, the
- split halves method, and the
- internal consistency method.

1.11 ETHICS

In the context of research, according to Saunders, Lewis and Thornhill, (2001:130), "… ethics refers to the appropriateness of your behaviour in relation to the rights of those who become the subject of your work, or are affected by it". The following ethics will be observed in the research study:

- **Informed consent:** Participants should be given the choice to participate or not to participate, and furthermore be informed in advance about the nature of the study.
- **Right to privacy:** The nature and quality of participants' performance must be kept strictly confidential.
- **Honesty with professional colleagues:** Findings must be reported in a complete and honest fashion, without misrepresenting what has been done or intentionally misleading others as to the nature of it. Data may not be fabricated to support a particular conclusion.
- **Confidentiality/Anonymity:** It is good research practice to offer confidentiality or anonymity, as this will lead to participants giving more open and honest responses.

1.12 RESEARCH ASSUMPTIONS

The following research assumptions will apply to this research study:

- The OEM's have the right to request new requirements from their suppliers irrespective of the supplier status or rating.
- The component suppliers are obligated to meet all requirements they are subjected to by the OEM to ensure 'future business'.
- Management systems must be robust to prevent defective components reaching the customer, but also flexible to absorb new requirements.

1.13 RESEARCH CONSTRAINTS

The following constraints apply to the research:

- The limitations in this research pertain to the fact that the research will only focus on the catalytic converter industry, whereas customer specific requirements are applicable to all component suppliers in the motor industry.
- The application of customer specific requirements is not by choice. If an organisation wishes to do any business with a motor manufacturer, the organisation must accept and implement the customer specific requirements applicable to the OEM.

1.14 CHAPTER AND CONTENT ANALYSIS

The following chapter and content analysis will be applicable to the proposed research study:

Chapter 1 - Scope of the research: To provide a holistic perspective of research parameters as they apply to supply chain management and the influence of customer specific requirements on the quality management system of a supplier.

Chapter 2 - Research environment: In this chapter, supply chain management from a supplier's perspective in the motor industry, focusing on catalytic converter industry will be analysed in detail.

Chapter 3 – Quality Improvement- a literature review: The literature review in this chapter will focus on supply chain management, quality management systems and the cost of quality.

Chapter 4 - Research Survey: In this chapter, the research survey design and methodology will be elaborated upon.

Chapter 5 - Data Analysis and interpretation: In this chapter, data gleaned from the research survey in chapter 4, will be analysed and interpreted.

Chapter 6 – Conclusion: In this chapter, the research will be concluded. Key elements raised will be revisited and recommendations will be made not only to mitigate the research problem, but also to provide an answer to the research question and the associated investigative questions.

1.15 SIGNIFICANCE OF THE PROPOSED RESEARCH

The research will provide 'value in use', which means that business and management practitioners involved in supply chain management will glean useful insight in the complexities associated with customer quality requirements. Furthermore, the review of the management system infrastructure at the RFQ stage will assist suppliers to

evaluate their financial readiness and from a manufacturer perspective, to meet the customers requirement. The commitment to quality will be subjected to the suppliers ability to meet the customers requirements or to implement the requirements prescribed by the customer.

CHAPTER 2: BACKGROUND AND INSIGHT TO THE RESEARCH PROBLEM

2.1 CATALYTIC CONVERTERS

Globally there are millions of cars on the roads and each one is a source of air pollution. For the large cities of the world, the pollution produced from all the cars creates air quality problems. Air pollution like smog, could hamper visibility and increase respiratory health concerns and problems like asthma. To solve these problems, cities, provinces and governments in Europe and the United States of America (USA) embarked on creating clean-air legislation that restricts the amount of pollution that cars can produce. Car manufacturers have over the years introduced many refinements to car engines and fuel systems to stay within the legal requirements. One of the introductions by the automakers was a device called a catalytic converter. The purpose of the catalytic converter is to convert harmful pollution into less harmful emissions, before the exhaust fumes leave the exhaust system of the car's engine.

Catalytic converters typically consist of a ceramic or metal honeycombed monolith substrate that carries precious metal catalysts. The coated substrate is wrapped in an intumescent mat that expands when heated, securing and insulating the substrate which is packaged in a stainless steel shell and fitted into the engine exhaust system. Figure 2.1 reflects of catalytic converters after the coating process. Figure 2.2 reflects a dissected schematic display of a completed canister after the canning process. Figure 2.3 reflects a complete canister as would be fitted to the motor car's exhaust system.

As exhaust gases pass over the catalysts, they promote chemical reactions that convert pollutants into harmless gases and water. Hydrocarbons combine with oxygen to become carbon dioxide; oxides of nitrogen react with carbon monoxide to produce nitrogen and carbon dioxide; and with hydrogen to produce nitrogen and water vapour.

The catalyst formulation, which promotes a faster chemical reaction at a lower temperature, is usually a mixture of the noble metals platinum, palladium and rhodium, and sometimes other catalysts such as the rare earth ceria.

A catalytic converter is not a stand-alone cure-all for emissions control. Unleaded fuel is required to operate properly. Catalytic converters are fitted as part of an engine management subsystem and are an integrated specific-purpose emission control components.

Figure 2.1 A large pile of platinum lined catalytic converters. (**Source:** Amos, 2009: **Online**)

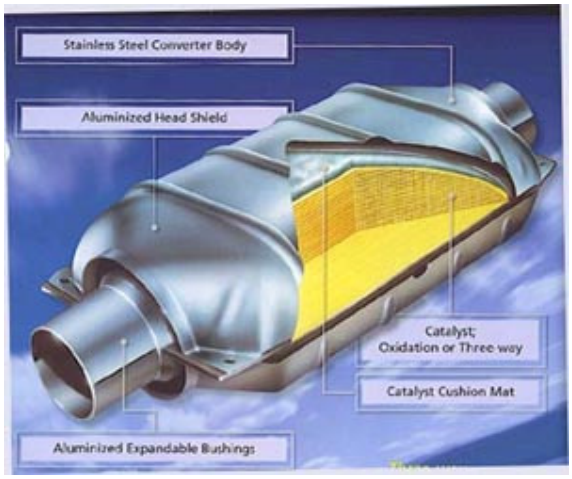

Figure 2.2 Dissected schematic of the components of a catalytic converter. **(Source:** Anonymous 5, 2009**: Online)**

Figure 2.3 A completed under floor catalytic converter as part of the exhaust system. (**Source**: Anonymous 6, 2009: **Online**)

2.2 THE CATALYTIC CONVERTER INDUSTRY

The Catalytic Converter Industry (CCI) forms part of the component supply chain to the motorcar manufacturers (automakers) also known as the Original Equipment Manufacturer (OEM). The catalyst forms part of the exhaust system. The catalytic converter supply chain consists of the substrate supplier, the coater, the mat supplier, wire mesh supplier and the canner. Table 2.1 define the key three suppliers in the CCI supply chain.

Table 2.1: Key supply chain flow in the catalytic converter industry. (**Source**: own)

Substrate suppliers	**Coaters**	**Canners**
Third tier suppliers	Second tier suppliers	First tier suppliers
➢ Produce monolith ceramic substrates. ➢ The inner core that simulates a honey comb. ➢ Supply the honeycomb substrates to the coaters	➢ Apply wash coating and precious metals like platinum, rhodium and palladium to the surface area of the substrates. ➢ Apply various coating techniques to minimise cost and optimise the catalytic characteristics ➢ Supply to the canners	➢ Place the coated substrates in an aluminium canister ➢ Place a 'mat' around the coated substrate before canning. ➢ Place a wire mesh between substrates where more than one substrate is fitted in a canister.

The ‘canner’ fits end cones to the ends of the can and the rest of the exhaust is fitted. First tier suppliers supply their products direct to the motorcar manufacturer.

2.3 THE QUALITY MANAGEMENT SYSTEM INITIATIVES IN THE MOTOR INDUSTRY

The motor industry has its own quality management requirement called the ISO/TS 16949 specification. The technical specification was introduced to unify the individual standards that existed in the motorcar manufacturing countries or nations. In Germany there was VDA, the United States of America had QS9000, in Italy there was AVSQ and in France EAQF. For component suppliers that supplied a generic component, it was difficult to maintain a quality management system that covered all the different motor car manufacturers from the different countries.

To bridge this challenge, it was agreed upon by all motorcar manufacturers to develop one standard. The technical committee tasked with this assignment could not get a two third majority vote to introduce the new standard and therefore the technical specification ISO/TS 16949 was accepted as a form of standardisation to unify the different existing standards. To ensure buy-in from all role players to the specification, the committee added Customer Specific Requirements to accommodate the individual needs of each motorcar manufacturing country. The original release termed ISO/TS 16949:1997 was upgraded in 2002 and again in 2008. The ISO/Technical Specification is based on the principles of ISO 9000:2000. The clauses are the same with additional requirements specific to the motor industry. All customer specific requirements are published on the Internet on the Automotive Industry Action Group’s (AIAG) website. All component suppliers must be certified to either the ISO 9000:2000 standard or the ISO/TS 16949 specification. Certification is done by independent Certification bodies that are register by the International Automotive Oversight Bureau (IAOB).

2.4 THE INTERNATIONAL AUTOMOTIVE OVERSIGHT BUREAU

The IAOB is an International Automotive Task Force (IATF) oversight office (Anonymous 7, 2009: **Online**). The IAOB is a Michigan Corporation; members include Chrysler LLC, Ford Motor Company, General Motors and the Automotive Industry Action Group (AIAG).

The International Automotive Oversight Bureau (IAOB) was established:

- To implement and manage the ISO/TS 16949 registration scheme oversight activities on behalf of the IATF.
- To coordinate with the IATF European Oversight Offices to ensure global consistency of the ISO/TS 16949 registration scheme.
- To support the IATF in the pursuit of global harmonization with other automotive manufacturers.
- To develop and maintain a central IATF database of strategic information to assist in the management of the registration scheme.

2.5 SUPPLY CHAIN MANAGEMENT

The motorcar manufacturers have outsourced the bulk of the vehicles components to independent suppliers. This was to streamline their activities to the core business, which is building cars. In some cases like the catalytic converter industry, there are a group of suppliers that are interlinked to supply a single unit to the motorcar manufacturers, an aspect which is referred to as a supply chain. OEM's manage the supply chain through Supplier Quality Engineers commonly referred to as SQE's. The SQE's have the responsibility to ensure that the products produced by each supplier meet the specification requirements specific to their activities. Each OEM has its own approach to manage the supply chain. The General Motors SQE's for example, would manage the entire supply chain for a particular program known as a platform. The SQE will witness the initial production runs and approve the release of the part to the next supplier in the supply chain. Other OEM's like PSA select the first tier supplier and abdicate the responsibility to appoint and manage the rest of the supply chain to the 'canner'. The OEM controls the entire chain and can conduct audits on all suppliers.

2.6 SOUTH AFRICA – DEVELOPING AND EMERGING MARKETS

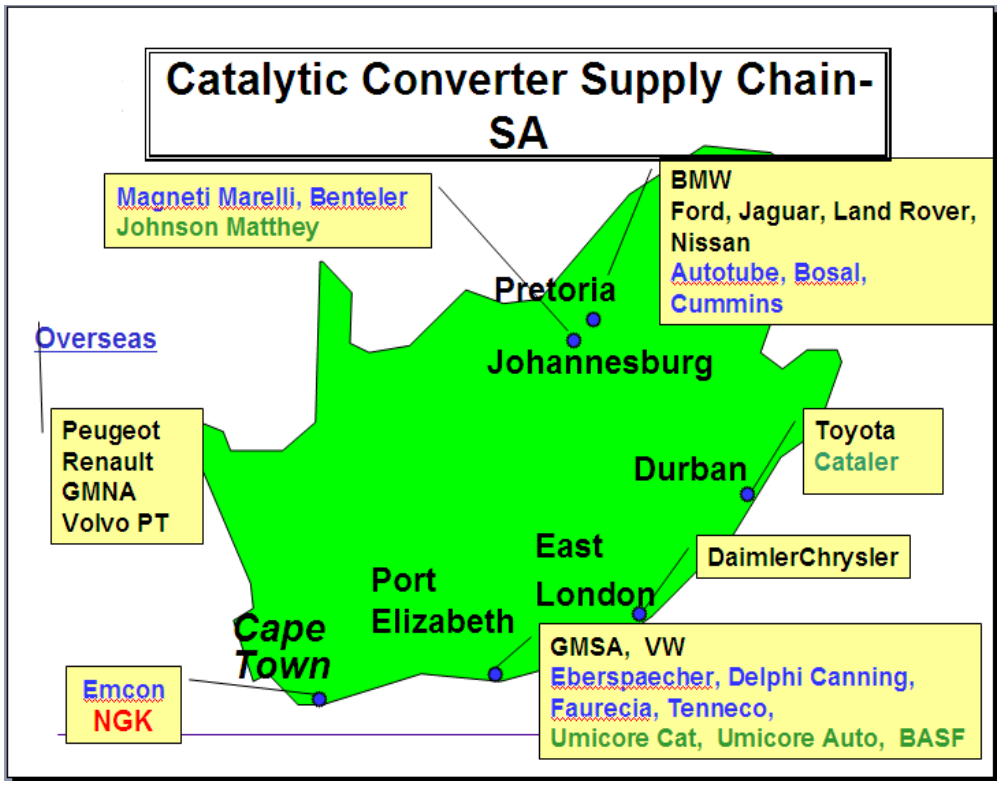

Figure 2.4 Geographic location of the catalytic converter supply chain in South Africa. (**Source**: Anonymous 8, NGK Ceramics South Africa: 2009, Presentation)

OEMs like General Motors (GM) have additional requirements for 'developing countries', also regarded as ‘emerging markets’. This is to ensure that the quality of the supply chain is maintained in these countries. Countries like South Africa, Brazil and India fall in this category. However, the technology applied by suppliers that have set-up business in the developing countries is equal to if not better than the levels in existing or first world countries. Suppliers like substrate manufacturers, coaters and canners have set-up base in South Africa because or the Motor Industry Development Plan know known as Automotive Component Development Plan (ACDP). This plan works on a credit based exchange whereby OEMs obtain import credits on exports that have been manufactured in South Africa. Through this plan, the OEM can improve the profit margins on vehicle sales in South Africa. The catalytic converter suppliers like, NGK Ceramics, Corning, BASF, Umicore, Johnson Matthey, Emcon, Faurecia, Bosal, Tenneco and Cummins, all have the ‘mother companies’ based in first world countries and apply the same operation standards in

South Africa as abroad. Figure 2.4 reflects the geographic locations of suppliers in the CCI supply chain.

2.7 CUSTOMER REQUIREMENTS VERSUS CUSTOMER SPECIFIC REQUIREMENTS

Customer Requirements (CR) are those requirements and specifications pertaining to the products. CR details specification regarding the material used and dimensions. Customer Specific Requirements (CSR) are those requirements that impact on the Quality Management system (QMS) of suppliers. It emphasis the clauses or elements specified the ISO/TS 16949 specification but with more importance to the particular OEM. Continual improvement activities at the OEM are rolled out to suppliers in the form of additional requirements. The introduction of such improvement requirements more often than not are rolled out after the business has been awarded to a supplier. In most instances, it costs money for the supplier to comply with the new or changed requirements that are imposed by the OEM.

2.8 REQUEST FOR QUOTATION

When the OEM envisage to build a new vehicle, the Procurement, Research and Development team with the OEM's QA representative set out criteria per supplier to tender for the business. The new vehicle build is known as a platform. The emission control goes hand in hand with the engine build due to the back pressure requirement that influence the performance of the engine. The Sales and Marketing teams of the suppliers are mainly focused on cost as a driver. For a supplier to be awarded business from the OEM is significant for any supplier. The extent of the supply of components is subject to the sale of the vehicle and the aftermarket components produced after the 'run-out' of the vehicle lifecycle.

During the tendering process, if the supplier has the QA infrastructure required and the capacity and facility with the correct price they will be awarded the business. Manufacturing specifications and product specifications are agreed to be approved by the OEM. However, the QMS is subjected to the ISO/TS requirements and the customer specific requirements. The CSR gives the OEM the right to subject

suppliers with additional requirements at the expense of the supplier. Although the component specification and manufacturing requirement are fixed and changes could result to an increase in cost, the QMS requirements are more open for change.

2.9 COST OF QUALITY

Most companies use Cost of Quality (COQ) as a yardstick to determine either the actual or fictitious amount of income through poor quality. Cost of quality has various models but the crux of the expense is to establish the lost of profit or revenue through appraisal, preventive measure and failure.

Appraisal costs include all inspection related activities related to cost. These include human and mechanical evaluation of product quality. Preventive costs include all the activities to prevent defects from slipping through the system and being shipped to the customer. This includes internal audits, training, meetings, etc. Failure costs refer to the rejects found during inspection known as internal failure cost. Defects found by the customer are known as external failures. These costs include the replacement cost of defect products, as well as the meeting cost to find the root cause.

Cost of quality should not be more than five percent of the overall sales. The investment in appraisal and preventive cost reduces internal and external failure and therefore contributes to the profit margin of the organization. Minimising customer complaints help the organizations' marketing image and future successful business tenders.

2.10 THE QUALITY MANAGEMENT SYSTEM

A QMS is a set of policies and rules to manage the business effectively and efficiently to facilitate transparency and traceability in the management of the business, unlike financial management where the organization can be subjected to financial forensic audits to ensure financial capacity and corporate governance.

The QMS assures that the organization is structured within the basic principles of management called Plan Lead Control (PLC) management. The QMS starts with a

business plan where for management set either their long term and or their annual plan for the business. This plan is also embedded in the quality manual, which consists of the policy, procedures, work instructions, forms and records. The QMS is structured around the elements or clauses as defined in the technical specification ISO/TS, as well as the process that will have a direct impact on customers. These processes are known as 'customer orientated processes'. This could be the manufacturing process, the sales process, the procurement process, the management review process, the delivery process, the payment and account receivable process. The support process would be the procurement, maintenance, recruitment, selection and placement activities of staff members.

All risk in each process must be identified and managed. The process of identifying risk is termed a 'Turtle Tool', where the Inputs, Activities and Outputs are defined. The QMS is managed through regular meetings by management to discuss 'quality', 'delivery' and cost saving initiatives. Internal systems and process audits are conducted to ensure that the QMS is maintained and sustained by the process owners. Management review meetings are held at least once per annum to evaluate the effectiveness of the system and discuss future activities.

CHAPTER 3: QUALITY IMPROVEMENT, A LITERATURE REVIEW

3.1 THE CONCEPT MODULAR SUPPLY CHAIN DEFINED

Doran (2004:**Online**), a senior lecturer at Kingston Business School, UK has focussed his research on modular supply chains in the motor industry, rather than the typical value chain, which is non-modular. Doran (2004:**Online**), defines 'modular' as a chain of activities whereby the smaller subsystems can be designed independently, and yet contribute to the end product as a whole. Furthermore, the author explains that a continuum of first tier suppliers range from 'mature' through 'developing' to 'fringe' first tier suppliers. In terms of modular supply chains, both the first tier suppliers as well as the second tier suppliers can have stringent quality assurance programs that can dictate what they expect from third tier suppliers. It is this quality system requirement, which influences the supplier's management system over and above the specification and delivery criteria.

3.2 THE BENEFITS OF THE MODULAR APPROACH

The 'Smart' car collaboration between the watch maker Swatch and Mercedes-Benz, is defined as a representation of modular approach (Doran 2004:**Online**). The Smart car collaboration has been engineered and designed using twenty – five module suppliers. The benefits of this approach for the OEM, culminated in less direct suppliers to deal with, lower costs to the OEM, and less risk and investment.

The module supplier benefited in terms of the increase responsibility, the greater involvement in development and design processes, and a higher proportion of value creation activity.

3.3 DEFINING A MODULE

Although the concept of what constitutes a 'module' differs from OEM to OEM, with some OEMs defining modules in relation to function, form or element (Doran 2004:**Online** citing Carbone, 1999), the modular concept requires first tier suppliers to deliver complete modules, rather than individual components. As a result, value-

transfer activity as indicated in Figure 3.1, refers to the process of identifying which value-creation activities can be pushed up the supply chain in order for module suppliers to focus primarily upon value creation activities that are viewed as core to the module production process (Doran, 2004:**Online**).

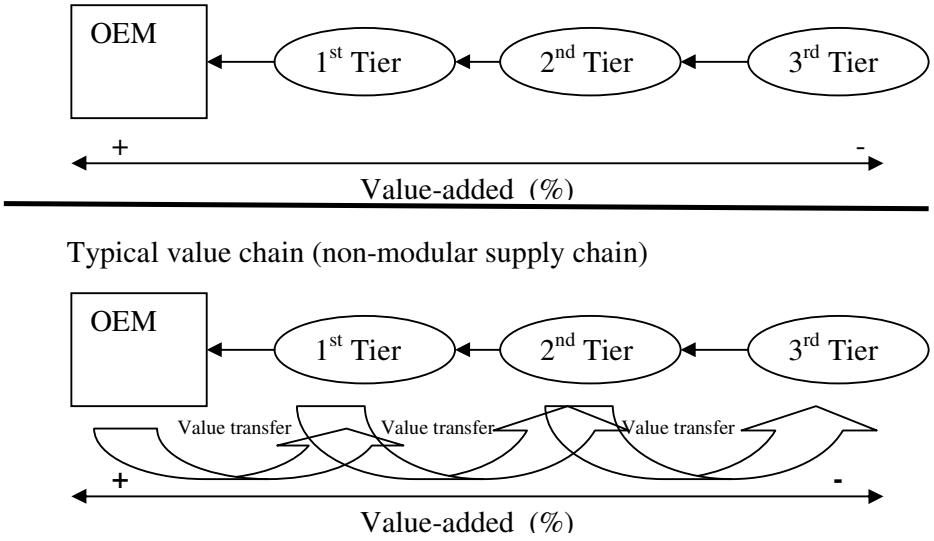

Figure 3.1 Typical value chain, non-modular supply chain (Source: Doran , 2004: **Online**)

3.4 THE IMPACT OF LEAN PRODUCTION

Söderquist and Motwani (1999:1107-1122), are of the opinion that the automobile industry provides a compelling example of how US and European carmakers, who historically relied on mass production, have shifted their focus to 'lean production', in order to produce cars lower in cost and higher in quality, as in the instance of their Japanese counterparts. According to the Mayo Medical Laboratories (2009:**Online**), the definition of **'**Lean Manufacturing' reads as follows: "A management philosophy focusing on reduction of the seven wastes (over-production, waiting time, transportation, processing, inventory, motion and scrap) in manufactured products. By eliminating waste, quality is improved, and production time and cost are reduced. Lean 'tools' include constant process analysis, 'pull' production, and mistake-proofing". The key issue in achieving 'lean production', is that firms must learn to view the process of managing as a total inter-firm system within entire production

chains, and not as a collection of independent techniques applied in independent companies (Söderquist and Motwani, 1999:1107-1122). This total system solution to lean production has compelled auto manufacturers to force their suppliers to introduce lean production techniques into their production process to achieve integration and rapid, frequent flow of goods and information within production chains (Levy, 1997:94-102).

It is the 'push' from the various motor companies that creates problems, since each motor company has its own method and approach to breach the gap between themselves and their competitors. The supplier is not involved and is required to accept all these 'techniques' or strategies as 'customer specific requirements'. The integrated quality management system as discussed by Söderquist and Motwani (1999:1107-1122), would work well if the supplier only supplied into one car manufacturer, however the system becomes more complex if the supplier feeds into more than one motor manufacturer. In a study conducted by Söderquist and Motwani (1999:1107-1122), it was determined that the quality targets and predicted organisational measures were often viewed as too 'directive and bureaucratic'. In their conclusion, the authors stated that the power of the car manufacturer is still perceived as being too strong, and improvement targets are imposed rather than negotiated.

3.5 THE SOUTH AFRICAN AUTOMOTIVE INDUSTRY

Lorentzen and Barns (2004:471), describe the complexity of the motor industry, the system of relations between vehicle assemblers and the component and part suppliers. The authors show how 'lean production' methods affect the entire value chain, whereby even the third tier supplier has to accommodate engineering changes.
The research covers the South African market with regards to vehicle manufacturing and component suppliers. Organisationally, the relationship between vehicle assemblers and component and part suppliers are amongst to most complex in any industry.
Lean production methods affect the entire value chain. Third tier supplier must in principal be in a position to accommodate engineering changes to be implemented in ongoing manufacturing process (Lorentzen and Barns, 2004:471-498 citing

MacDuffie and Helper, 1997). Lorentzen and Barns (2004:471-498), determined that it makes sense for a vehicle manufacturer with an investment in a developing country to rely on tested and trusted relationships with preferred suppliers that set up production close to wherever their customer goes. International companies operating in 'developing countries', are likely to lose design and engineering capabilities, and the auto industry in these countries will contribute little to the hope for technological capability within manufacturing at large.

3.6 THE CURRENT SOUTH AFRICAN MOTOR MANUFACTURING SITUATION

According to Lorentzen and Barns (2004:465-498), the industry employs over 100000 people who are paid above average salaries. The 2002 turnover was close to ZAR100 billion. In 2002, the total automotive production was worth 5.7 percent of the GDP, and accounted for 12 percent of exports.

3.7 MEASUREMENT OF QUALITY

Traditionally, performance measures and indicators have been derived from cost-accounting information, often based on outdated and arbitrary principles (Oakland, 2000:117). According to Oakland (2000:118), Total Quality Management (TQM), stresses the need to start to measure the process for fulfilling customer needs. The critical elements for good performance measurements include leadership and commitment, full employee involvement, good planning, sound implementation strategy, measurement and evaluation, control and improvement, and achieving and maintaining standards of excellence (Oakland, 2000:118). According to Oakland (2000:128), manufacturing quality products, providing quality service, or doing a quality job, is not enough. The cost of achieving these goals must be carefully managed, to ensure that the long-term effect on the business or organisation is a desirable one.

According to Tsai (1998:**Online**), the Cost of Quality (COQ) information can be used to indicate major opportunities for corrective action and to provide incentives for quality improvement. Tsai (1998:**Online**) discusses the numerous approaches to

measuring COQ, and categorises quality cost into a Prevention-Appraisal-Failure (PAF) model (Tsai, 1998:**Online** citing Feigenbaum, 1956). Furthermore, that failure cost could be classified into two subcategories, namely 'internal failure' and 'external failure' cost (Tsai, 1998:**Online** citing Oakland, 1993). Prevention costs are defined as those cost associated with the design, implementation and maintenance of total quality management systems. Appraisal costs are those costs associated with the supplier's and customer's evaluation of purchased materials, processes, intermediates, products and services to assure conformance with specific requirements. Internal failure costs are costs that occur when the results of work fail to meet the designed quality standards, and are detected in the supplier's process.
External failure costs are costs that occur when nonconforming products or services are detected by the customer. Typical COQ elements defined by Tsai (1998:**Online**), are elaborated upon below:

Prevention includes:

- Quality control and process control engineering,
- Design and develop control equipment,
- Quality planning,
- Maintenance and calibration of production equipment,
- Maintenance and calibration of test, measurement and inspection equipment,
- Quality assurance activities,
- Training,
- Audits.

Appraisal includes:

- Laboratory testing,
- Inspection and testing,
- In-process inspection (non-inspectors),
- Set-up for inspection and test,
- Inspection and test materials,
- Product quality audits.

Internal failure includes:

- Rejects,

- Rework and repair,
- Troubleshooting, defect analysis,
- Re-inspect, retest,
- Concessions,
- Downgrading.

External failure includes:

- Customer complaints,
- Product service liability,
- Returned material for repair,
- Warranty replacements,
- Loss of sales.

3.8 COST OF QUALITY

According to Weheba (2004:**Online**), the total cost of conformance is made to include two functions. The first estimates the cost incurred while maintaining stable operation at an existing level of conformance (L_o), and as a result termed 'relative costs'. These include the cost of monitoring the state of operation (C_m); The cost of inspecting production units (C_i) and the cost of deviating from performance targets (C_d) in terms of average (expected) values, the total relative cost per unit time of operations is expressed as:

$E(RC) = E(C_m) + E(C_i) + E(C_d)$

The Cost of Conformance accounts for the cost of attaining an improve level of conformance (L_1). This includes the elements:

- Test and evaluation cost, and
- implementation cost

Y = The total operation time per interest period

L = The effective interest rate

As a result, the equation for cost saving expected upon achieving the improved level L_1 is equivalent to $\{E(RC)_0 - E(RC)_1\}$

3.9 THE PAF APPROACH

Tsai (1998:**Online**), citing Oakland (1993), believes that the drawbacks of the Cost of Quality Catogorised into Prevention, Appraisal and Failure (PAF) approach are as follows:

- The difficulty to define prevention quality failures as most activities by organisation is geared to prevent quality problems.
- Not all prevention activities in any company are included in the report of quality cost.
- Organisations that achieved reduction in quality costs do not always seems to have greatly increased their prevention cost.
- The original PAF does not include intangible quality costs such as "lost of customer goodwill" and lost of sales".
- It is difficult to uniquely classify cost.
- The PAF categories do not consider process cost.

3.10 PRICE OF CONFORMANCE / PRICE OF NON-CONFORMANCE

Alternatives to the PAF approach is defined by Tsai (1998:**Online**) citing Crosby (1984) as the Price of Conformance (POC), and the Price of Non-Conformance (PNOC). POC includes all costs related in producing product right the first time. Where as PNOC includes all cost related to not producing the product right the first time. Crosby's POC includes prevention and inspection cost, whilst his PNOC includes internal and external failure costs (Tsai 1998:**Online** citing Shank and Govindarajan, 1994).

3.11 PROCESS COST APPROACH

According to Tsai (1998:**Online**), process cost is the total of the Cost of Conformance (COC) and the Cost of Non-Conformance (CONC) for a particular process. Tsai (1998:**Online**) citing Porter and Rayner (1992) elaborate on the definition of COC as the actual process cost of providing products or services to the required standard, first time and every time. CONC in turn is defined as the failure cost associated with a process not being operated to the required standard.

Deficiencies of most COQ systems have been identified as the overhead allocation in calculating COQ. That most of the COQ measurement systems in use are not intended to trace quality costs to their source (Tsai, 1998:**Online**).

3.12 ACTIVITY BASE COSTING

A two-dimensional model of Activity Base Costing (ABC) is defined. This covers the cost calculations of overheads in relation to process and product cost. The process view of ABC is composed of three building blocks namely cost drivers, activities and performance measures. The process provides information on why the activities are performed via cost drivers, and how well the activities are performed via performance measures. According to Tsai (1998:**Online)** the cost drivers identify the cause of activity cost and are useful as it identify action required at the root cause level, namely that it identifies opportunity for improvement. Using ABC to improve a business is commonly referred to as Activity Based Management (ABM).
In comparison, the activities / cost categories of COQ are defined as:

- PAF approach – prevention, appraisal, internal failure and external failure
- Process cost approach - conformance and non-conformance
- ABS – value added and the non-value-added.

3.13 INTERACTION BETWEEN SUPPLIERS

Yue, Jie and Yuan (2006:209-213), in their article 'Achieving Reliability in Original Equipment Manufacturer (OEM)/Original Design Manufacturer (ODM), Customer Premises Equipment (CPE) Products', define the benefits of interaction between suppliers and the OEM. The research contains fundamentals that positively contribute to a more reliable output and better customer satisfaction. According to Yue, *et al.* (2006:209-213), Lucent Technologies developed a programme to ensure that their suppliers conducted reliability studies to determine expected mean times between failures. Through this partnership, their suppliers were encouraged to produce components, whereby the market reliability expectations were defined, resulting in the production of high quality products. Lucent Technologies furthermore developed a standard, which their suppliers had to meet to be able to become a preferred supplier.

The ISO/TS16949 Technical Specification coupled with applicable customer–specific requirements, defines the fundamental quality management system requirements (Anonymous 9, ISO/TS16949:2009 Manual:xii).

3.14 CREATING SUPPLY CHAIN VALUE

According to a publication from the Automotive Industry Action Group (AIAG, 2009: **Online**), on the web page entitled 'The AIAG Dividend: Creating Supply Chain Value', the approach is to create a common platform whereby players in the motor industry can share, learn and positively contribute to create a work environment whereby both the OEMs and suppliers benefit. In this article, the AIAG define themselves as a unique not-for-profit organisation where, retailers, automakers, suppliers, service providers, academia and Government have worked collaboratively to streamline industry processes and business practices for 25 years.

The board of directors includes automakers like Daimler AG, Chrysler AG, Ford Motor Company, General Motors Corporation, Honda of America Manufacturing Inc. and Toyota Motor Manufacturing North America as well as Caterpillar, International Truck and Engine Corporation.

The AIAG works closely with sister organisations in Europe (Odette and VDA), Japan (JAMA/JAPIA) and most recently China (CAAM), to provide leadership direction and alignment for streamlining activities. The AIAG also provides effective communication and delivery of consistent quality requirements, guidelines, education and training to supply base worldwide.

The AIAG has introduced a new Supply Chain Institute, through which quality aptitude certification can be validated and verified. Effectiveness of APQP/PPAP, FMEA, MSA and SPC training received from any organisation. Certificate holders will belong to an elite group of quality professionals, that can demonstrate Quality Core Tool proficiency to their employers.

The AIAG (2009:**Online**), also indicate how to establish a guidance document for the supply chain when developing CSR. This is to address the lack of standard

format and content criteria in customer specific requirements. The purpose of the guideline is to ensure that the requirements have the proper focus and alignment with ISO/TS 16949. The guideline document also define how to align requirements with ISO/TS 16949 clause numbers, and distinguish and separate ISO/TS 16949 customer requirements from commercial/contractual and engineering related requirements.

3.15 THE SCOPE OF SUPPLY CHAIN MANAGEMENT RESEARCH

New (1997:15-22), advocates an expanded scope for supply chain management research, considering 'social functions', 'political' and 'economical' implications of supply chain management. New (1997:15-22), argues that supply chain management must not be driven by industrial interest alone. When customers forget that suppliers are business entities that also need to be sustainable to ensure their existence, the impact of all the customer specific requirements could impose challenges to the operation of an organisation, and could lead to exploitation.

New (1997:15-22), presents an argument that supply management is far too important to be considered either a temporary fad or a parochial arena for a guild of specialist researchers. In the article the author also indicates that research in supply chain management must not be constrained by an assumed correspondence between the 'economic principle' and the 'benefit of society'. The three meanings of supply chain indicated by New (1997: 15-22), are:

- The supply chain from the perspective of an individual firm,
- A supply chain related to a particular product or item, and
- 'Supply chain' used as a handy synonym for purchasing, distribution and material management.

According to New (1997:15-22), researchers must untangle complex language games of aspiration and propaganda when managers and businesses report supply chain developments.

3.16 SUPPLIER RELATIONS

Choy and Lee (2002:**Online**) believe that the rapid increase in information technology is now deployed, not only to improve existing operational effectiveness on a business, but also to build the new capability to meet today's business environment and complexity. The core activity of manufacturing is no longer confined to making things, but lies in the systematic processing of knowledge to create value for customers (Choy and Lee, 2002:**Online**). Any change in strategy should enable manufacturers to be better equipped with capabilities to cope with demands as faster response to the market changes, shorter lead time of production, improve quality products and speed, improve communication and transportation systems, are commonly referred to as Case Base Reasoning (CBR).

Decision making in supplier management, based on human decisions, are usually determined according to general attributes of limited processes. The CBR technique is 'retrieval', 'revise', 'reuse' and 'retain' (Choy and Lee, 2002:**Online** citing Damodt and Plaza, 1994). According to Choy and Lee (2002:**Online**), the steps include:

- Retrieve the most similar situation from a set of cases, according to enquiry on request.
- Reuse the cases to sole the problems in order to construct the solution of the new problem. The solution becomes the output of a propose solution.
- Revise the suggested solution if there is a difference between the new problem and the retrieved one. This solution is verified and exported as a solution.
- Retain the new solution as knowledge in a case database for future stages.

The concept of lean supply and subsequent theoretical developments in the areas of relationship management have led firms to conclude that they will more readily attain long-term cost reduction by forming closer working relations with key suppliers (Choy and Lee, 2002:**Online**).

3.17 SETTING A CUSTOMER POLICY

According to Bailey (1994:**Online**), the old adage, "the customer is always right" was never intended to turn those who deal with customers into doormats, nor to act as a catch-all for those who want to make unreasonable demands in an unpleasant way. The saying which remains important is in reality about:
The customer has rights,

- Customers' rights must be recognised and protected,
- Organisations depend on customers and must view and treat them as important,
- Strong customer focus.

It is important for suppliers to define a policy based on knowing customer rights and the organizations statutory duties and legal obligations and duties. In the policy the basic minimum requirement that can be exceeded must be defined (Bailey, 1994: **Online**).

3.18 SUPPLY CHAIN MANAGEMENT IN ITS CONTEXT

The activities, processes and relationships which fall under the supply chain label are central to industrial modernity. New (1997:**Online)** believes that to a great extent the details of life for all are deeply affected by the impact of supply chain this is evident from the wellbeing of the West to the poverty of the so-called developing, world and intertwined by complex networks of global production and distribution. Supply chain management is about the mechanisms and process by which these activities are organised (New, 1997:**Online**)

According to New (1997:**Online**) the concerned questions of politics and ethics which have traditionally be side-lined in the academic development on the subject of supply chain management. The three issues that serves as examples, the following:

- The exploration of poor producers of the so-called 'development world'.
- The concentration and imbalances of economic power in the corporate economy.
- In a general sense 'the environment' which includes everybody.

New (1997:**Online**) citing Burns and New (1996) explore how the cost and benefits of collaboration between supply chain partners are divided, and show how simple conceptions of 'win-win' are inadequate to explain inter-firm behaviour.

3.19 CONCEPTUAL MODEL FOR TOTAL QUALITY MANAGEMENT (TQM)

According to Sureshchandar, Rajendran and Anantharaman (2001:343-363), the subject of quality management in the manufacturing industry has been a matter of increasing interest, but also of concern. The authors refer to the various dimensions, techniques and organisational requirements for effective implementation of Total Quality Management (TQM). Although the research focused on TQM in service organisations, the fundamentals of total quality management system was raised, namely; 'that decision-makers become more involve in implementing TQM and questions are raised about which management practices should be emphasised'.

3.20 THE ORIGIN OF TQM

According to Sureshchandar *et al.* (2001:343-363) citing Steward (1931), the origin of TQM movement dates back to the early twentieth Century when Walter Shewart first introduced the concept of Statistical Process Control (SPC) to monitor quality in mass production manufacturing. This concept was followed by a plethora of quality gurus and quality practitioners who all advocated various approaches to TQM. Amongst those cited in the article includes Cosby (1979) (the four absolutes), Deming (the fourteen points), Feigenbuam (1993) (total quality control), Isikawa (1985) quality control circles, Juran *et al.* (1988), (quality trilogy) and Tagushi (1986),(lost function).

According to Sureshchandar *et al.* (2001:343-363), the subject of quality management in the manufacturing industry has been a matter of great interest and concern for business and academia alike. Several researchers have thoroughly investigated the various dimensions, techniques and organisational requirements for the effective implementation of TQM. The dimensions include top management commitment and leadership, quality policy, training, product/service design, supplier

quality management, process management, quality data and reporting, employee relations, workforce management, customer focus, customer involvement, benchmarking, SPC, employee empowerment, employee involvement, corporate quality culture and strategic quality management. These dimensions are tools of the intellect that were forged in the administrative theory, tempered in manufacturing quality management and are therefore expected to hone to cutting sharpness in service quality management.

Sureshchandar *et al.* (2001:343-363), developed a conceptual model of twelve dimensions of quality management as critical for the institution of a TQM environment on services organisations as indicated in Figure 3.2.The twelve dimensions include:

- Top management commitment and visionary leadership.
- Human resource management.
- Technical system.
- Information and analyse system.
- Benchmarking.
- Continuous improvement.
- Customer focus.
- Employee satisfaction.
- Union intervention.
- Social responsibility.
- Services capes.
- Service culture.

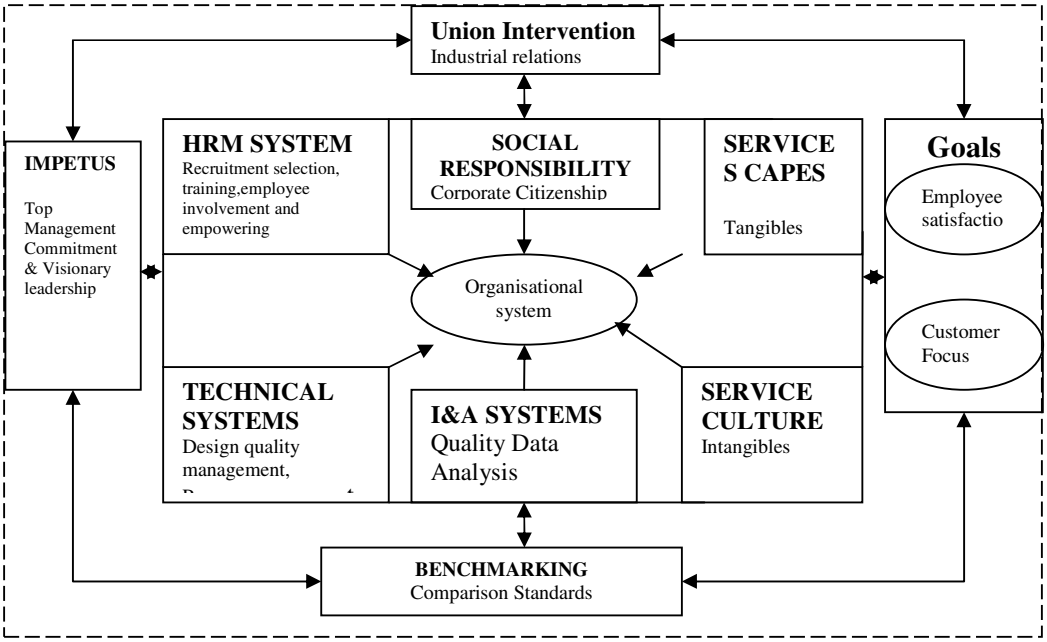

Figure 3.2: An integrative framework for total quality *service (***Source:** Sureshchandar *et al.,* 2001: 356)

According to Chan and Qi (2003:**Online**), manufacturers face increasing pressure of customer requirements in product customisation, quality improvement and demand responsiveness. Chan and Qi (2003:**Online**), define SCM as a totally new technology of managing the business and the relationships amongst all members, back to the original suppliers and out to the end customer.

Moon and Kim (2005:**Online**), indicate that the claims that systems thinking interventions can produce beneficial change in thinking, behaviour or organizational performance have outstripped evaluative research testing these claims. Systems' thinking includes the ability to:

- Understand how the behaviour of a system arises from interaction or its agents over time.
- Discover and represent feedback process (positive or negative / hypothesized to underlie observed patterns of system behaviour).
- Identify stock and flow relationships.
- Recognize and challenge the boundaries of mental (and formal) models.

Cox (1999:**Online**) indicated that Toyota had the good sense to recognise that the only way for the company to compete was to turn necessity into a virtue. As a result Toyota's lean production and assembly system is focussed on providing the highest level of quality to the customer, given whatever amount the customer is able to pay.
The value chain exists in parallel with the supply chain and refers to the flow of revenue from the end consumer of any product and service. The supply chain and the value chain exist in a fundamental exchange relation (Cox 1999:**Online** citing Cox 1997a).

3.21 Understanding and implementing a quality management system

Goetsch and Davis (2002:54), believe that all the requirements of the clauses as defined in the ISO 9001:2001 standard should be met and built into the quality management system of an organisation. The implementation of a quality management system is a requirement of the ISO 9001 structure, and forms part of clause 4 requirements. The ISO 9001 structure consists of: Clause 1 – Scope, Clause 2 – Normative References, Clause 3 – Terms and Definitions, Clause 4 – Management system, Clause 5 – Management Responsibility, Clause 6 – Resource Management, Clause 7 – Product Realisation. Clause 8 – Measurement, Analysis and Improvement. A schematic depiction of the above is contained within the ambit of Figure 3.3.

In terms of Clause 4.1 of ISO 9001:2000, the organisation shall establish, document, implement and maintain a quality management system and continually improve it effectiveness in accordance with the requirements of ISO 9001:2000 (Goetsch and Davis, 2002:178). According to Goetsh and Davis (2002:178), to lead and operate an organisation successfully requires managing it in a systematic and visible manner. To achieve success, a management system should be implemented and maintained to ensure the effectiveness and efficiency of the organisation's performance, by considering the requirements of interested parties like customers.

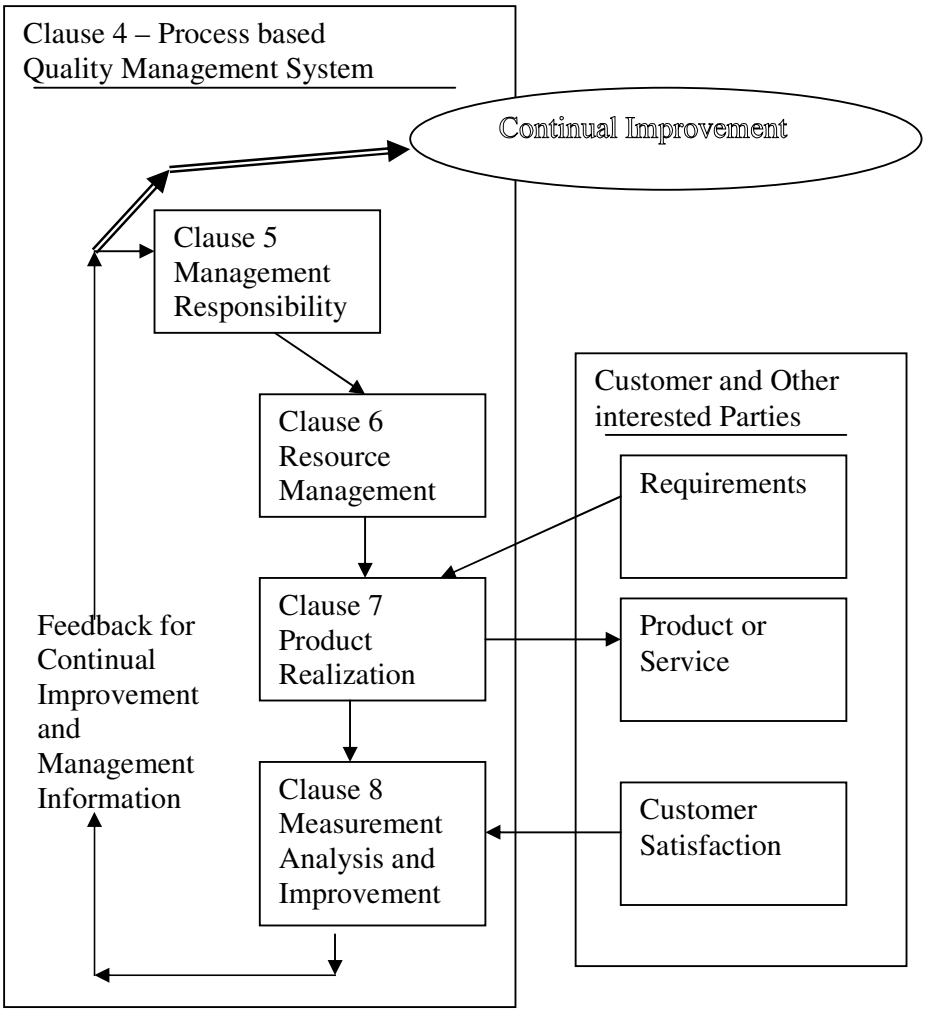

Figure 3.3: Process-based quality management system model (**Source**: Goetsch and Davis, 2002:56)

3.22 BUSINESS REQUIREMENTS

According to Smith (1989:963-981), the overall purpose of business requirements analysis is to determine user and organisational needs. Grithens (2000:49), define 'requirement' and 'specification' as:

- **Requirement**: The capacity or capability that is needed for describing the project's product, thus satisfying a set of customer purposes.
- **Specification**: A formal notation of requirement.

The pitfalls to be observed when formulating business requirement specifications are as follows (Land and Kennedy-McGregor (1987:87):

- The system when implemented meets the requirement established when the business requirement specifications were formulated (possibly two or three years previously), and not the present day requirements.
- The system is based on a model of the real world and of real world behaviour, which is untested and often in error.
- Failure to capture the deep knowledge about the system, which those who have to work with it, possess.

3.23 QUALITY SPECIFICATIONS

Gilbert (1983:103), indicated the following three step process in which quality specification can be attained:

- Define the broad objectives of the system.
- Refine each broad objective into a set of detailed objectives.
- Quantify each detailed objective and desired system quality.

According to Huff (1992:50), quality first and foremost, means conformance to specifications, whereas Pirsig (1989:253), defines quality as the response of an organisation to it environment. Goetsch and Davis (2002:47), defines requirements as a need or expectation that may be stated as an ISO 9000 requirement or a contract requirement, or may be implied through common practice.

3.24 CONCLUSION

The literature review in this dissertation focussed on the supply chain and quality associated thereto. The various permutations of the concept of quality was elaborated upon in detail, ultimately leading to the obvious analogy that additional requirements adversely affect the supply chain, however if managed appropriately, the issues can be mitigated.

CHAPTER 4: RESEARCH SURVEY DESIGN AND METHODOLOGY

4.1 THE SURVEY ENVIRONMENT

The Catalytic Converter Industry consists of various suppliers, each with a unique value adding activity. The scope of the research survey will include the following:

- The Coaters
- The Canners.
- The OEM

4.2 AIM OF THIS CHAPTER

The aim of this chapter and the survey contained therein is to determine the views of role players in the catalytic converter industry regarding the impact of customer specific requirements on their quality management system. The ultimate objective being to solve the research problem as defined in Chapter 1, Paragraph 1.3, and which reads as follows: *"The requirements of the OEM's to demand that customer specific requirements are built into the QMS's leads to complexity in the supply chain"*.

4.3 CHOICE OF SAMPLING METHOD

Purposive sampling will be applied in this research, choosing the quality assurance managers of second and first tier suppliers to complete a survey questionnaire. The entire population regarding second and first tier suppliers will be sampled.

Random sampling will be applied to supplier quality engineers and supplier technical assistants that will represent the OEM's views. Structured interview methodology as described by Cooper and Schindler (2006:204, 208, 210-211) will be applied to solicit data from the OEM's perspective.

4.4 THE TARGET POPULATION

With any survey, it is necessary to clearly define the target population, which Collis and Hussey (2003:157), define as follows: *"A population is any precisely defined set of people or collection of items which is under consideration"*.

The 'sampling frame' defined by Vogt (1993) and cited by Collis and Hussey (2003:155-160), as 'a list or record of the population from which all the sampling units are drawn. For this survey, 5 Coaters, representing the entire population, 4 Canners randomly selected from a population of 6 and 3 OEM's based in South Africa represent the sampling frame. This transposes in 12 role players in the industry from different organisations being randomly selected from the following identified research strata:

- The Coaters.
- The Canners.
- The OEM.

The supply chain in the catalytic converter industry has a three level hierarchy, which is made up as follows:

- **The substrate supplier:** The third tier supplier and is responsible to produce the honeycomb substrate.
- **The coater:** The second tier supplier and is responsible for coating the substrate with precious metals that catalyse the harmful exhaust gasses emitted from the motor vehicle engine, to environmental friendly gasses.
- **The canner:** The first tier supplier and is responsible to canister the coater substrate to form part of the exhaust system.
- **The Original Equipment Manufacturer (OEM):** Assemble the motor vehicle from components supplied by first tier suppliers.

The Quality Assurance managers were targeted to complete the survey questionnaire from a supplier perspective. The Suppliers Quality Engineers from the OEMs were targeted to represent the view from the OEM's. The target population was specifically chosen in order to validate the practicality of the concepts as presented here. The risk of bias, which cannot be statistically eliminated, is recognised by the

author based on the very definition of the target population as well as the number of respondents selected.

4.5 DATA COLLECTION

According to Easterby-Smith, Thorpe and Lowe (1996:133-134) the use of multiple, but independent measures is known as triangulation, of which four categories can be recognised namely:

- Theoretical triangulation,
- Data triangulation,
- Investigator triangulation and
- Methodological triangulation.

In this survey the methodological triangulation method was used which culminated in data collection through questionnaires and interviews.

Interviews, according to Collis and Hussey (2003:64), are associated with both positivist and phenomenological methodologies. They are a method of collecting data in which selected participants are asked questions in order to find out what they do, think or feel. The use of personal interviews as an additional element to the data collection process is in the opinion of the author important, since this allows for the identification of issues within the target environment, which may not be readily identifiable using a pure survey questionnaire. Furthermore, according to Collis and Hussey (2003:64), interviews are associated with both positivist and phenomenological methodologies as employed within the ambit of this dissertation.

The data collection method used in the survey, falls within the context of a survey, defined by Collis and Hussey (2003:60), as: "A sample of subjects being drawn from a population and studied to make inferences about the population"

More specific, the survey conducted in this dissertation falls within the ambit of the 'descriptive survey' as defined by Ghauri, Grønhaug and Kristianslund (1995:64). The concept of 'survey' is defined by Remenyi et al. (2002:290) as: "… the collection of a large quantity of evidence usually numeric, or evidence that will be

converted to numbers, normally by means of a questionnaire". A survey will be conducted to collect 'primary data' using the 'personal interview' method to conduct the interviews, an approach which maps to accepted data collection methods

The data collection method used fall within the ambit of both the definitions attributed to the concepts 'survey' and 'field study'. 'Survey', according to Gay and Diebl (1992:238), is an attempt to collect data from members of a population in order to determine the current status of that population with respect to one or more variables, while Kerlinger (1986:372), define 'field study' as non-experimental scientific inquiries aimed at discovering the relations and interactions among … variables in real … structures. As in the case of most academic research, the collection of data forms an important part of the overall dissertation content.

4.6 MEASUREMENT SCALES

The survey will be based on the well-known Likert scale, whereby respondents were asked to respond to questions or statements (Parasuraman 1991:410). The reason for choosing the Likert scale, the fact that the scale can be used in both respondent-centred (how responses differ between people) and stimulus-centred (how responses differ between various stimuli) studies, most appropriate to glean data in support of the research problem in question (Emory and Cooper 1995:180-181). The advantages in using the popular Likert scale according to Emory and Cooper (Emory and Cooper 1995:180-181) are:

- Easy and quick to construct.
- Each item meets an empirical test for discriminating ability.
- The Likert scale is probably more reliable than the Thurston scale, and it provides a greater volume of data than the Thurston differential scale.
- The Likert scale is also treated as an interval scale.

According to Remenyi, Money and Twite (1995:224), interval scales facilitate meaningful statistics when calculating means, standard deviation and Pearson correlation coefficients.

4.7 THE DEMAND FOR A QUALITATIVE RESEARCH STRATEGY

While this author acknowledges that a number of strategies can be applied in similar research projects, the well-known concepts of objectivity, reliability etcetera, inherited from the empirical analytical paradigm, is suggested for business research in more or less the traditional way. Quoting Thorndike and Hagen, these concepts are defined by Emory and Cooper (1995:156), as follows:

- **Practicality:** Practicality is concerned with a wide range of factors of economy, convenience, and interpretability.
- **Validity:** Validity refers to the extent to which a test measures what we actually wish to measure. Yin (2003:34), identifies 3 subsets to the concept validity, namely: Construct validity, internal validity and external validity.
- **Reliability:** Reliability has to do with the accuracy and precision of a measurement procedure.

4.8 SURVEY SENSITIVITY

Research conducted in areas of a sensitive nature as in the case of this survey, pose particular challenges to the researcher. The following guidelines from various academics serve to illustrate the mitigation process, which can be deployed in an instance where research is conducted in areas of a sensitive nature:

- A qualitative investigation of a particularly sensitive nature conducted by Oskowitz and Meulenberg-Buskens (1997:83), qualified the importance of handling mission critical issues as identified above when the authors stated: "Thus any type of qualitative investigation could benefit from the researchers being skilled and prepared, and the sensitive nature of an investigation into a stigmatizing condition made the need for such an undertaking even more imperative in the current study".

- The sensitivity of certain issues and issues identified as impacting the research negatively in the environments being evaluated, not only demand intimate personal involvement, but also demand the 'personal and practical experience' of the researcher. This view was upheld by Meulenberg-Buskens (1997:83), as being imperative to assure quality in qualitative research being undertaken.

Checkland (1989:152), supports this view however extends the concept with the opinion that: "The researcher becomes a participant in the action, and the process of change itself becomes the subject of research".

4.9 SURVEY DESIGN

Collis and Hussey (2003:60) are of the opinion that, 'if research is to be conducted in an efficient manner and make the best of opportunities and resources available, it must be organised. Furthermore, if it is to provide a coherent and logical route to a reliable outcome, it must be conducted systematically using appropriate methods to collect and analyse the data. A survey should be designed in accordance with the following stages:

- **Stage one:** Identify the topic and set some objectives.
- **Stage two:** Pilot a questionnaire to find out what people know and what they see as the important issues.
- **Stage three:** List the areas of information needed and refine the objectives.
- **Stage four:** Review the responses to the pilot.
- **Stage five:** Finalise the objectives.
- **Stage six:** Write the questionnaire.
- **Stage seven:** Re-pilot the questionnaire.
- **Stage eight:** Finalise the questionnaire.
- **Stage nine:** Code the questionnaire.

The survey design to be used in this instance is that of the descriptive survey as opposed to the analytical survey. The descriptive survey is according to Collis and Hussey (2003:10), frequently used in business research in the form of attitude surveys. The descriptive survey as defined by Ghauri, Grønhaug and Kristianslund (1995:60), has furthermore the characteristics to indicate how many members of a particular population have a certain characteristic. Particular care was taken to avoid bias in the formulation of the questions.

The statements within the survey have been designed with the following principles in mind:

- Avoidance of double-barrelled statements.

- Avoidance of double-negative statements.
- Avoidance of prestige bias.
- Avoidance of leading statements.
- Avoidance of the assumption of prior knowledge.

Statements were so formulated as to allow the same respondents to respond to each of the two questionnaires, to determine if a paradigm shift occurred after the concept of 'knowledge management' was adopted.

4.10 THE VALIDATION SURVEY QUESTIONS

The author has developed two separate survey questionnaires. Due to the fact that face-to-face interviews are highly structured, questions were prepared and piloted to ensure they reflected a high degree of 'validity' Babbie (2005:285).

4.10.1 Tier two and tier one questionnaire: The impact of customer specific requirements on suppliers and supply chain management

Question 1: Request for additional customer specific requirements like Quality Systems Basics (QSB) from GM and Material Management Operations Guideline Logistics Evaluation (MMOG/LE) from Ford creates additional work for your organisation. To what extent to do you agree with this statements?

Question 2: The flexibility required from your quality management system, makes the quality management system ineffective. To what extent to do you agree with this statements?

Question 3: To successfully manage multiple and diverse customer specific requirements pose a challenge to ensure buy-in from all employees. To what extent to do you agree with this statements?

Question 4: Your Company's quality management system is susceptible to errors that can lead to non-conforming conditions when subjected to multiple customer specific requirements. To what extent to do you agree with this statements?

Question 5: New customer specific requirements like MMOG/LE and additional customer specific requirements like QSB add value to your processes. To what extent to do you agree with this statements?

Question 6: The implementation of numerous customer specific requirements adds value to your organisation's quality management system. To what extent to do you agree with this statements?

Question 7: New applications of customer specific requirements are regarded as continual improvement initiatives to improve your quality management system. To what extent to do you agree with this statements?

Question 8: The automotive manufacturer (OEM) provides training on customer specific requirements. To what extent to do you agree with this statements?

Question 9: The OEM substitutes the cost for implementing new customer specific requirements when the new requirements require modifications to you systems or processes. To what extent to do you agree with this statements?

Question 10: The capability to obtain new business for your organisation is strengthen by implementing all the customer specific requirements from all the OEMs. To what extent to do you agree with this statements?

Question 11: Your organisation regards customer requirements and customer specific requirements as one and the same. To what extent to do you agree with this statements?

Question 12: The OEMs request for work place improvement requirements and electronic data interface systems between suppliers' causes little to no disruptions to your organisation. To what extent to do you agree with this statements?

Question 13: The request for work place improvement requirements and electronic data interface systems between suppliers and the OEM is beneficial for both the supplier and the OEM. To what extent to do you agree with this statements?

Question 14: Your organisation support lower tier suppliers, with resources to obtain and maintain your customer specific requirements? To what extent to do you agree with this statements?

Question 15: It is beneficial and value adding for your organisation to get your suppliers to be compliant to the customer specific requirements from the OEM's. To what extent to do you agree with this statements?

Question 16: Your organisation has its own customer specific requirements that your suppliers must adhere to. To what extent to do you agree with this statements?

Question 17: Your organisation has introduced and sustains all customer specific requirements from the OEM's you deal with. To what extent to do you agree with this statements?

Question 18: Customer specific requirements are entrenched in your manufacturing process and all employees are familiar with each OEM's requirement. To what extent to do you agree with this statements?

4.10.2 OEM QUESTIONNAIRE: THE IMPACT OF CUSTOMER SPECIFIC REQUIREMENTS ON SUPPLIERS AND SUPPLY CHAIN MANAGEMENT

Question 1: The automotive manufacturer requires the implementation of customer specific requirements to assure the quality of the commodity procured from the supplier. To what extent to do you agree with the statement?

Question 2: The automotive manufacturer value the supplier's quality management system. To what extent to do you agree with the statement?

Question 3: The automotive manufacturer has the right to subject the supplier to additional requirements in the form of customer specific requirements. To what extent to do you agree with the statement?

Question 4: The purpose of customer specific requirements is to ensure sustainable quality (products, delivery and service) from suppliers. To what extent to do you agree with the statement?

Question 5: Customer specific requirements add value to the supplier's quality management system. To what extent to do you agree with the statement?

To what extent do you agree with the following statement?

Question 6: Customer specific requirements add value to a supplier's processes. To what extent to do you agree with the statement?

Question 7: Customer specific requirements ensure that the suppliers have clear guidelines n the control and monitoring of their production and service facilities. To what extent to do you agree with the statement?

Question 8: The automotive manufacturer applies the same or similar requirements in their production and assembly facilities. To what extent to do you agree with the statement?

Question 9: Customer specific requirements contribute to mutual beneficial supplier relationships. To what extent to do you agree with the statement?

Question 10: Customer specific requirements and additional requirements like work place improvement and electronic data transfer are introduced with the aim to

minimise the risk to the automotive manufacturer. To what extent to do you agree with the statement?

Question 11: The automotive manufacturer support suppliers with resources and training? To what extent to do you agree with the statement?

Question 12: The automotive manufacturer train the entire supply chain when changes or additions to customer specific requirements are introduced. To what extent to do you agree with the statement?

Question 13: The automotive manufacturer provides financial support to implements new customer specific requirements to all suppliers. To what extent to do you agree with the statement?

Question 14: Where suppliers have similar activities as specified in customer specific requirements by the automotive manufacturer, the supplier has the right to keep their own standards. To what extent to do you agree with the statement?

Question 15: Generally lower tier suppliers find it difficult to sustain customer specific requirements. To what extent to do you agree with the statement?

Question 16: First tier suppliers' quality management systems are complex and leads to non conforming products being delivered to the automotive manufacturer? To what extent to do you agree with the statement?

Question 17: New customer specific requirements are introduced with the intent to develop supplier to a required expected level of quality as part of the automotive manufacturers continual improvement drive. To what extent to do you agree with the statement?

Question 18: The automotive manufacturers ensure that all tier suppliers adhere to customer specific requirements. To what extent to do you agree with the statement?

Question 19: The intent of customer specific requirement is the reduce co**st** whilst increase productivity from all suppliers. To what extent to do you agree with the statement?

Question 20: It is the responsibility of each supplier to ensure that their suppliers implement customer specific requirements from the automotive manufacturers. To what extent to do you agree with the statement?

4.11 CONCLUSION

In this chapter, the 'impact of customer specific requirements' survey design and methodology was addressed under the following functional headings:

- Survey environment.
- Aim of the chapter.
- Choice of sampling method.
- Target population.
- Data collection.
- Measurement scales.
- Demand for a qualitative research strategy.
- Survey sensitivity.
- Survey design.
- Survey questions.

In Chapter 5, results from the survey will be analysed in detail and conclusions drawn.

CHAPTER 5: RESEARCH SURVEY DESIGN AND METHODOLOGY

5.1 INTRODUCTION

Data analysis refer to the process of bringing order, structure and meaning to the mass of collected data (de Vos 2002, 339). This chapter discusses the results of the data analysis of the survey conducted within the Catalytic Converter Industry (CCI). The aim of this study is to determine the requirements of the Original Equipment Manufacturers (OEM) to demand that customer specific requirements are built into the Quality Management Systems (QMS), which minimizes the impact on the supply chain. The data obtained from the completed questionnaires will be presented and analysed by means of various analyses (uni-variate, bi-variate and multivariate) as it becomes applicable.

The data has been analysed by using SAS software. As descriptive statistics, frequency tables displayed in Paragraph 5.3.2 shows the distributions of biographical variables and statement responses. As a measure of central tendency, Table 5.4 shows the means and standard deviation of the statement responses as well. Comparative statistics for comparing information for type of respondent (1^{st} tier suppliers and 2^{nd} tier suppliers) using Chi-square tests and the Wilcoxon Rank-Sum (Mann-Whitney U) tests for two independent samples are discussed in Paragraph 5.3.4 and the computer printouts are shown in Annexure B.

5.2 ANALYSIS METHOD

5.2.1 Validation survey results

A descriptive analysis of the survey results returned by the research questionnaire respondents is reflected below. The responses to the questions obtained through the questionnaires are indicated in table format for ease of reference. Each variable is tested to fall within the boundaries.

5.2.2 Data format

The data received from the questionnaires was in Microsoft Excel format. It was then imported into SAS-format through the SAS ACCESS module. This information was analysed by the custodian of this document.

5.2.3 Preliminary analysis

The reliability of the statements (items) in the questionnaire posted to the sample drawn from the Catalytic Converter Industry (CCI) is measured by using the Cronbach Alpha tests. (See Paragraph 5.3.1). Descriptive statistics were performed on all variables; displaying means, standard deviations, frequencies, percentages, cumulative frequencies and cumulative percentages. These descriptive statistics are discussed in Paragraphs 5.3.2 and 5.3.3. (See also computer printout in Annexure A).

5.2.4 Inferential statistics

The following inferential statistics are performed on the data:

- Cronbach Alpha test. Cronbach's Alpha is an index of reliability associated with the variation accounted for by the true score of the "underlying construct". Construct is the hypothetical variables that are being measured (Cooper and Schindler, 2006:216-217). More specific, Cronbach's alpha measures how well a set of items (or variables) measures a single uni-dimensional latent construct.
- Kruskal Wallis test for interval data with more than 2 independent samples. The Kruskal-Wallis one-way analysis of variance by ranks is a non-parametric method for testing equality of population medians among groups. Intuitively, it is identical to a one-way analysis of variance with the data replaced by their ranks. It is an extension of the Mann-Whitney U test to 3 or more groups. Since it is a non-parametric method, the Kruskal-Wallis test does not assume a normal population, unlike the analogous one-way analysis of variance. However, the test does assume an identically-shaped and scaled distribution for each group, except for any difference in medians.

- Mann-Whitney U test or Wilcoxon rank-sum test for ordinal data with two independent samples. The Mann-Whitney *U* test (also called the Mann-Whitney-Wilcoxon (MWW), Wilcoxon rank-sum test, or Wilcoxon-Mann-Whitney test) is a non-parametric test for assessing whether two samples of observations come from the same distribution. The null hypothesis is that the two samples are drawn from a single population, and therefore that their probability distributions are equal. It requires the two samples to be independent, and the observations to be ordinal or continuous measurements, i.e. one can at least say, of any two observations, which is the greater. In a less general formulation, the Wilcoxon-Mann-Whitney two-sample test may be thought of as testing the null hypothesis that the probability of an observation from one population exceeding an observation from the second population is 0.05.
- Chi-square tests for nominal data. The Chi-square (two-sample) tests are probably the most widely used nonparametric test of significance that is useful for tests involving nominal data, but it can be used for higher scales as well like cases where persons, events or objects are grouped in two or more nominal categories such as 'yes-no' or cases A, B, C or D. The technique is used to test for significant differences between the observed distribution of data among categories and the expected distribution based on the null hypothesis. It has to be calculated with actual counts rather than percentages (Cooper and Schindler, 2006:499).

5.2.5 Technical report with graphical displays

A written report with explanations of all variables and their outcome has been compiled. A cross analysis of variables where necessary was performed, attaching statistical probabilities to indicate the magnitude of differences or associations.
All inferential statistics are discussed in Paragraph 5.3.4.

5.2.6 Assistance to researcher

The conclusions made by the researcher, is validated by the statistical report. Help was given to interpret the outcome of the data. The final report written by the

researcher was validated and checked by the statistician to exclude any misleading interpretations.

5.2.7 Sample

The target population is the Catalytic Converter Industry. The total sample contains 5 respondents from automotive manufacturers or as in the case of the OEM's, 4 respondents known as 1st tier suppliers and 5 respondents known as 2nd tier suppliers. The sample was drawn based on a convenient sample targeting the quality representatives of the various organisations.

5.3 ANALYSIS

In total there were 5 OEM's, 4 1st tier suppliers and 5 2nd tier suppliers that answered the questionnaire posted to them. The items (statements) in the questionnaires will be tested for reliability in the following paragraph.

5.3.1. Reliability testing

Cronbach's Alpha is an index of reliability associated with the variation accounted for by the true score of the "underlying construct". Construct is the hypothetical variables that are being measured (Cooper and Schindler, 2006:216-217). More specific, Cronbach's alpha measures how well a set of items (or variables) measures a single uni-dimensional latent construct.

The reliability test (Cronbach's Alpha Coefficient) was done on all the items (statements) which represent the measuring instrument of this survey, with respect to the responses rendered in this questionnaire. The Cronbach's Alpha Coefficients reported in Table 5.1 shows that the measuring instrument is not consistent. This however proves that the questionnaire may by multi dimensional and it measures more than one construct. This problem can be dealt with, by determining whether there are more dimensions in which this questionnaire operates in (in other words that the statements describe more than one latent variable), by doing a factor analysis

on the questionnaire or by deleting the items that add to the inconsistency of the questionnaire. The latter was done and the results are presented in Tables 5.2 and 5.3.

TABLE 5. 1: Cronbach's Alpha Coefficients on all items in the supplier questionnaire

Statements	Variable nr.	Correlation with total	Cronbach's Alpha Coefficient
1. Request for additional customer specific requirements, creates additional work for your organisation.	Q01	0.1822	0.5393
2. The flexibility required from your management system, makes the quality management system ineffective.	Q02	0.3834	0.5031
3. To successfully manage multiple and diverse customer specific requirements (CSR) pose a challenge to ensure buy-in from all employees.	Q03	0.2958	0.5188
4. Your company's quality management system is susceptible to errors that can lead to non-conforming conditions when subjected to multiple CSR.	Q04	-0.1342	0.5903
5. New CSR add value to your processes.	Q05	0.0465	0.5619
6. The implementation of numerous CSR adds value to your organisation's quality management system.	Q06	-0.0447	0.5869
7. New applications of CSR are regarded as continual improvement initiatives to improve your quality management system.	Q07	0.1595	0.5449
8. The OEM provides training on CSR.	Q08	0.2823	0.5246
9. The OEM substitutes the costs for implementing new CSR when the new requirements require modifications to your system or processes.	Q09	0.2233	0.5336
10. The capability to obtain new business for your organisation is strengthen by implementing all the CSR from all the OEMs.	Q10	0.5056	0.4808
11. Your organisation regards customer requirements and CSR as one and the same.	Q11	0.2572	0.5225
12. The OEMs request for work place improvement requirements and electronic data interface systems	Q12	0.4151	0.4890

Statements	Variable nr.	Correlation with total	Cronbach's Alpha Coefficient
between suppliers' causes little to no disruptions to your organisation.			
13. The request for work place improvement requirements and electronic data interface systems between suppliers' and the OEM is beneficial for both.	Q13	0.3078	0.5210
14. Your organisation support lower tier suppliers with resources to obtain your CSR.	Q14	-0.0281	0.5693
15. It is beneficial and value adding for your organisation to get your suppliers to be compliant to the CSR from the OEMs.	Q15	0.7484	0.4909
16. Your organisation has its own CSR that your suppliers must adhere to.	Q16	0.2911	0.5159
17. Your organisation has introduced and sustains all CSR from the OEM's you deal with.	Q17	-0.0733	0.5611
18. CSR are entrenched in your manufacturing process and all employees are familiar with each OEM's requirement.	Q18	-0.1135	0.5814
Cronbach's Coefficient Alpha for standardized variables			**0.5850**
Cronbach's Coefficient Alpha for raw variables			**0.5515**

TABLE 5. 2: Cronbach's Alpha Coefficients on 1st selected items in the supplier questionnaire

Statements	Variable nr.	Correlation with total	Cronbach's Alpha Coefficient
1. Request for additional customer specific requirements, creates additional work for your organisation.	Q01	0.5543	0.7552
2. The flexibility required from your management system, makes the quality management system ineffective.	Q02	0.3506	0.7791
3. To successfully manage multiple and diverse customer specific requirements (CSR) pose a challenge to ensure buy-in from all employees.	Q03	0.7064	0.7379
8. The OEM provides training on CSR.	Q08	0.2979	0.7828

Statements	Variable nr.	Correlation with total	Cronbach's Alpha Coefficient
10. The capability to obtain new business for your organisation is strengthen by implementing all the CSR from all the OEMs.	Q10	0.5606	0.7551
11. Your organisation regards customer requirements and CSR as one and the same.	Q11	0.3496	0.7870
13. The request for work place improvement requirements and electronic data interface systems between suppliers' and the OEM is beneficial for both.	Q13	0.4336	0.7704
14. Your organisation support lower tier suppliers with resources to obtain your CSR.	Q14	0.1634	0.7968
15. It is beneficial and value adding for your organisation to get your suppliers to be compliant to the CSR from the OEMs.	Q15	0.4082	0.7769
16. Your organisation has its own CSR that your suppliers must adhere to.	Q16	0.7219	0.7298
17. Your organisation has introduced and sustains all CSR from the OEM's you deal with.	Q17	0.4873	0.7751
Cronbach's Coefficient Alpha for standardized variables			**0.7967**
Cronbach's Coefficient Alpha for raw variables			**0.7857**

TABLE 5. 3: Cronbach's Alpha Coefficients on 2nd selected items in the supplier questionnaire

Statements	Variable nr.	Correlation with total	Cronbach's Alpha Coefficient
5. New CSR add value to your processes.	Q05	0.6644	0.7496
6. The implementation of numerous CSR adds value to your organisation's quality management system.	Q06	0.8146	0.7031
7. New applications of CSR are regarded as continual improvement initiatives to improve your quality management system.	Q07	0.6568	0.7495
9. The OEM substitutes the costs for implementing new CSR when the new requirements require modifications to your system or processes.	Q09	0.8727	0.7307

Statements	Variable nr.	Correlation with total	Cronbach's Alpha Coefficient
12. The OEMs request for work place improvement requirements and electronic data interface systems between suppliers' causes little to no disruptions to your organisation.	Q12	0.7264	0.7307
18. CSR's are entrenched in your manufacturing process and all employees are familiar with each OEM's requirement.	Q18	-0.2025	0.8975
Cronbach's Coefficient Alpha for standardized variables			**0.7971**
Cronbach's Coefficient Alpha for raw variables			**0.8033**

Due to the fact that the same scales were used for the different questions, the Cronbach's Coefficient Alpha for raw variables which is equal to 0.7857 and 0.8033 was used, and proves these two groups of items to be reliable and consistent because it is more than the acceptable level of 0.70. It becomes clear that two constructs are measured.

The OEM questionnaire is not consistent. This could be due to various reasons. For instance there were only 5 respondents and for some of the items, all of them gave the same answer. These items were taken out and the rest of the items were tested for consistency. These were still not proven consistent. This however proves that the questionnaire may by multi dimensional and it measures more than one construct. This problem can be overcome by deleting the items that adds to the inconsistency of the questionnaire. The results are shown in Tables 5.4 and 5.5 and both these constructs prove to be consistent. Take note that items Q01 and Q09 are taken out due to the fact that all the respondents gave the same answer and thus no variability exists.

TABLE 5. 4: Cronbach's Alpha Coefficients on 1st sellected items in the OEM questionnaire

Statements	Variable nr.	Correlation with total	Cronbach's Alpha Coefficient
4. The purpose of customer specific requirements is to ensure sustainable quality from suppliers.	Q04	0.8789	0.7734
5. Customer specific requirements add value to the supplier's quality management system.	Q05	0.3204	0.8025
6. Customer specific requirements add value to a supplier's processes.	Q06	0.5474	0.7803
7. Customer specific requirements ensure that the suppliers have clear guidelines in the control and monitoring of their production and service facilities.	Q07	0.2238	0.8084
8. The automotive manufacturer applies the same or similar requirements in their production and assembly facilities.	Q08	-0.0163	0.8231
12. The automotive manufacturer train the entire supply chain when changes or additions to customer specific requirements are introduced.	Q12	0.7908	0.7402
13. The automotive manufacturer provides financial support to implements new customer specific requirements to all suppliers.	Q13	0.7336	0.7517
16. First tier supplier's quality management systems are complex and leads to non conforming products being delivered to the automotive manufacturer.	Q16	0.0658	0.8182
18. The automotive manufacturers ensure that all tier suppliers adhere to customer specific requirements.	Q18	.9583	0.7063
20. It is the responsibility of each supplier to ensure that their suppliers implement customer specific requirements from the automotive manufacturers.	Q20	0.3204	0.8025
Cronbach's Coefficient Alpha for standardized variables			**0.8042**
Cronbach's Coefficient Alpha for raw variables			**0.8018**

TABLE 5. 5: Cronbach's Alpha Coefficients on 2nd sellected items in the OEM questionnaire

Statements	Variable nr.	Correlation with total	Cronbach's Alpha Coefficient
2. The automotive manufacturer value the supplier's quality management system.	Q02	0.0754	0.7896
3. The automotive manufacturer has the right to subject the supplier to additional requirements in the form of customer specific requirements.	Q03	0.2744	0.7736
10. Customer specific requirements and additional requirements like work place improvement and electronic data transfer are introduced with the aim to minimise risk to the automotive manufacturer.	Q10	0.6744	0.7138
11. The automotive manufacturer support suppliers with resources and training.	Q11	0.6378	0.7448
14. Where suppliers have similar activities as specified in customer specific requirements by the automotive manufacturer, the supplier has the right to keep their own standards.	Q14	0.5238	0.7381
15. Generally lower tier suppliers find it difficult to sustain customer specific requirements.	Q15	0.1034	0.8048
17. New customer specific requirements are introduced with the intent to develop supplier to a required expected level of quality as part of the automotive manufacturers continual improvement drive.	Q17	0.8850	0.6545
19. The intent of customer specific requirements is the reduce cost whilst increase productivity from all suppliers.	Q19	0.7362	0.3917
Cronbach's Coefficient Alpha for standardized variables			**0.7574**
Cronbach's Coefficient Alpha for raw variables			**0.7713**

5.3.2 Descriptive statistics

Tables 5.6 and 5.7 show the descriptive statistics for all the information in the questionnaire that measure supplier responses with the frequencies in each category and the percentage out of total number of questionnaires. It is of importance to note

that the descriptive statistics are based on the total sample. These descriptive statistics are also shown in Annexure A. Table 5.8 shows the descriptive statistics like mean, standard deviation and range for the continuous variables.

TABLE 5. 6: Descriptive statistics for sample distribution

Variables	Categories	Frequency	Percentage out of total
Sample distribution			
Respondents	1st tier suppliers	4	30.8%
	2nd tier suppliers	5	38.5%
	OEM's	4	30.8%

TABLE 5. 7: Descriptive statistics for categorical variables of 1st and 2nd tier suppliers

Variables	Categories	Frequency	Percentage out of total
MEASURING INSTRUMENT			
1. Request for additional customer specific requirements, creates additional work for your organisation.	Strongly agree	3	33.3%
	Agree	3	33.3%
	Not sure	0	0.0%
	Disagree	3	33.3%
	Strongly disagree	0	0.0%
2. The flexibility required from your management system, makes the quality management system ineffective.	Strongly agree	0	0.0%
	Agree	2	22.2%
	Not sure	1	11.1%
	Disagree	5	55.6%
	Strongly disagree	1	11.1%
3. To successfully manage multiple and diverse customer specific requirements (CSR) pose a challenge to ensure buy-in from all employees.	Strongly agree	5	55.6%
	Agree	3	33.3%
	Not sure	0	0.0%
	Disagree	1	11.1%
	Strongly disagree	0	0.0%
4. Your company's quality management system is susceptible to errors that can lead	Strongly agree	0	0.0%
	Agree	4	44.4%

Variables	Categories	Frequency	Percentage out of total
to non-conforming conditions when subjected to multiple CSR.	Not sure	0	0.0%
	Disagree	5	55.6%
	Strongly disagree	0	0.0%
5. New CSR add value to your processes.	Strongly agree	1	11.1%
	Agree	7	77.8%
	Not sure	0	0.0%
	Disagree	0	0.0%
	Strongly disagree	1	11.1%
6. The implementation of numerous CSR adds value to your organisation's quality management system.	Strongly agree	1	11.1%
	Agree	3	33.3%
	Not sure	1	11.1%
	Disagree	3	33.3%
	Strongly disagree	1	11.1%
7. New applications of CSR are regarded as continual improvement initiatives to improve your quality management system.	Strongly agree	1	11.1%
	Agree	4	44.4%
	Not sure	0	0.0%
	Disagree	3	33.3%
	Strongly disagree	1	11.1%
8. The OEM provides training on CSR.	Strongly agree	0	0.0%
	Agree	2	22.2%
	Not sure	3	33.3%
	Disagree	4	44.4%
	Strongly disagree	0	0.0%
9. The OEM substitutes the costs for implementing new CSR when the new requirements require modifications to your system or processes.	Strongly agree	0	0.0%
	Agree	0	0.0%
	Not sure	2	22.2%
	Disagree	4	44.4%
	Strongly disagree	3	33.3%
10. The capability to obtain new business for your organisation is strengthen by implementing all the CSR from all the OEMs.	Strongly agree	1	11.1%
	Agree	5	55.6%
	Not sure	1	11.1%
	Disagree	2	22.2%

Variables	Categories	Frequency	Percentage out of total
	Strongly disagree	0	0.0%
11. Your organisation regards customer requirements and CSR as one and the same.	Strongly agree	1	11.1%
	Agree	3	33.3%
	Not sure	0	0.0%
	Disagree	4	44.4%
	Strongly disagree	1	11.1%
12. The OEMs request for work place improvement requirements and electronic data interface systems between suppliers' causes little to no disruptions to your organisation.	Strongly agree	0	0.0%
	Agree	3	33.3%
	Not sure	2	22.2%
	Disagree	2	22.2%
	Strongly disagree	2	22.2%
13. The request for work place improvement requirements and electronic data interface systems between suppliers' and the OEM is beneficial for both.	Strongly agree	2	22.2%
	Agree	3	33.3%
	Not sure	4	44.4%
	Disagree	0	0.0%
	Strongly disagree	0	0.0%
14. Your organisation support lower tier suppliers with resources to obtain your CSR.	Strongly agree	2	22.2%
	Agree	5	55.6%
	Not sure	1	11.1%
	Disagree	1	11.1%
	Strongly disagree	0	0.0%
15. It is beneficial and value adding for your organisation to get your suppliers to be compliant to the CSR from the OEMs.	Strongly agree	5	55.6%
	Agree	4	44.4%
	Not sure	0	0.0%
	Disagree	0	0.0%
	Strongly disagree	0	0.0%
16. Your organisation has its own CSR that your suppliers must adhere to.	Strongly agree	4	44.4%
	Agree	3	33.3%
	Not sure	0	0.0%
	Disagree	2	22.2%
	Strongly disagree	0	0.0%
17. Your organisation has introduced and	Strongly agree	2	22.2%

Variables	Categories	Frequency	Percentage out of total
sustains all CSR from the OEM's you deal with.	Agree	7	77.8%
	Not sure	0	0.0%
	Disagree	0	0.0%
	Strongly disagree	0	0.0%
18. CSR are entrenched in your manufacturing process and all employees are familiar with each OEM's requirement.	Strongly agree	0	0.0%
	Agree	4	44.4%
	Not sure	2	22.2%
	Disagree	3	33.3%
	Strongly disagree	0	0.0%

TABLE 5. 8: Descriptive statistics for the ordinal variables of 1st and 2nd tier suppliers

Variable	N	Mean	Median	Standard Deviation	Range
1. Request for additional customer specific requirements, creates additional work for your organisation.	9	2.33	2.0	1.3229	3
2. The flexibility required from your management system, makes the quality management system ineffective.	9	3.56	4.0	1.0138	3
3. To successfully manage multiple and diverse customer specific requirements (CSR) pose a challenge to ensure buy-in from all employees.	9	1.67	1.0	1.0000	3
4. Your company's quality management system is susceptible to errors that can lead to non-conforming conditions when subjected to multiple CSR.	9	3.11	4.0	1.0541	2
5. New CSR add value to your processes.	9	2.22	2.0	1.0929	4
6. The implementation of numerous CSR adds value to your organisation's quality management system.	9	3.00	3.0	1.3229	4
7. New applications of CSR are regarded as continual improvement initiatives to improve your quality management system.	9	2.89	2.0	1.3642	4
8. The OEM provides training on CSR.	9	3.22	3.0	0.8333	2

9.	The OEM substitutes the costs for implementing new CSR when the new requirements require modifications to your system or processes.	9	4.11	4.0	0.7817	2
10.	The capability to obtain new business for your organisation is strengthen by implementing all the CSR from all the OEMs.	9	2.44	2.0	1.0138	3
11.	Your organisation regards customer requirements and CSR as one and the same.	9	3.11	4.0	1.3642	4
12.	The OEMs request for work place improvement requirements and electronic data interface systems between suppliers' causes little to no disruptions to your organisation.	9	3.33	3.0	1.2247	3
13.	The request for work place improvement requirements and electronic data interface systems between suppliers' and the OEM is beneficial for both.	9	2.22	2.0	0.8333	2
14.	Your organisation support lower tier suppliers with resources to obtain your CSR.	9	2.11	2.0	0.9280	3
15.	It is beneficial and value adding for your organisation to get your suppliers to be compliant to the CSR from the OEMs.	9	1.44	1.0	0.5270	1
16.	Your organisation has its own CSR that your suppliers must adhere to.	9	2.00	2.0	1.2247	3
17.	Your organisation has introduced and sustains all CSR from the OEM's you deal with.	9	1.78	2.0	0.4410	1
18.	CSR are entrenched in your manufacturing process and all employees are familiar with each OEM's requirement.	9	2.89	3.0	0.9280	2

Table 5.9 shows the descriptive statistics for all the information in the questionnaire that measure OEM's responses with the frequencies in each category and the percentage out of total number of questionnaires. It is of importance to note that the descriptive statistics are based on the total sample. These descriptive statistics are also shown in Annexure A. Table 5.10 shows the descriptive statistics like mean, standard deviation and range for the continuous variables.

TABLE 5. 9: Descriptive statistics for categorical variables of OEM's

Variables	Categories	Frequency	Percentage out of total
MEASURING INSTRUMENT			
1. The automotive manufacturer requires the implementation of customer specific requirements to assure quality of the commodity procured from the supplier.	Strongly agree	5	100.0%
	Agree	0	0.0%
	Not sure	0	0.0%
	Disagree	0	0.0%
	Strongly disagree	0	0.0%
2. The automotive manufacturer value the supplier's quality management system.	Strongly agree	4	80.0%
	Agree	1	20.0%
	Not sure	0	0.0%
	Disagree	0	0.0%
	Strongly disagree	0	0.0%
3. The automotive manufacturer has the right to subject the supplier to additional requirements in the form of customer specific requirements.	Strongly agree	3	60.0%
	Agree	2	40.0%
	Not sure	0	0.0%
	Disagree	0	0.0%
	Strongly disagree	0	0.0%
4. The purpose of customer specific requirements is to ensure sustainable quality from suppliers.	Strongly agree	1	20.0%
	Agree	4	80.0%
	Not sure	0	0.0%
	Disagree	0	0.0%
	Strongly disagree	0	0.0%
5. Customer specific requirements add value to the supplier's quality management system.	Strongly agree	2	40.0%
	Agree	3	60.0%
	Not sure	0	0.0%
	Disagree	0	0.0%
	Strongly disagree	0	0.0%
6. Customer specific requirements add value to a supplier's processes.	Strongly agree	2	40.0%
	Agree	2	40.0%
	Not sure	0	0.0%
	Disagree	1	20.0%
	Strongly disagree	0	0.0%
7. Customer specific requirements ensure	Strongly agree	4	80.0%

Variables	Categories	Frequency	Percentage out of total
that the suppliers have clear guidelines in the control and monitoring of their production and service facilities.	Agree	1	20.0%
	Not sure	0	0.0%
	Disagree	0	0.0%
	Strongly disagree	0	0.0%
8. The automotive manufacturer applies the same or similar requirements in their production and assembly facilities.	Strongly agree	3	60.0%
	Agree	2	40.0%
	Not sure	0	0.0%
	Disagree	0	0.0%
	Strongly disagree	0	0.0%
9. Customer specific requirements contribute to mutual beneficial supplier relationships.	Strongly agree	0	0.0%
	Agree	5	100.0%
	Not sure	0	0.0%
	Disagree	0	0.0%
	Strongly disagree	0	0.0%
10. Customer specific requirements and additional requirements like work place improvement and electronic data transfer are introduced with the aim to minimise risk to the automotive manufacturer.	Strongly agree	2	40.0%
	Agree	2	40.0%
	Not sure	1	20.0%
	Disagree	0	0.0%
	Strongly disagree	0	0.0%
11. The automotive manufacturer support suppliers with resources and training.	Strongly agree	1	20.0%
	Agree	4	80.0%
	Not sure	0	0.0%
	Disagree	0	0.0%
	Strongly disagree	0	0.0%
12. The automotive manufacturer train the entire supply chain when changes or additions to customer specific requirements are introduced.	Strongly agree	2	40.0%
	Agree	0	0.0%
	Not sure	1	20.0%
	Disagree	2	40.0%
	Strongly disagree	0	0.0%
13. The automotive manufacturer provides financial support to implements new customer specific requirements to all suppliers.	Strongly agree	0	0.0%
	Agree	1	20.0%
	Not sure	2	40.0%
	Disagree	1	20.0%

Variables	Categories	Frequency	Percentage out of total
	Strongly disagree	1	20.0%
14. Where suppliers have similar activities as specified in customer specific requirements by the automotive manufacturer, the supplier has the right to keep their own standards.	Strongly agree	0	0.0%
	Agree	3	60.0%
	Not sure	0	0.0%
	Disagree	2	40.0%
	Strongly disagree	0	0.0%
15. Generally lower tier suppliers find it difficult to sustain customer specific requirements.	Strongly agree	0	0.0%
	Agree	1	20.0%
	Not sure	1	20.0%
	Disagree	3	60.0%
	Strongly disagree	0	0.0%
16. First tier supplier's quality management systems are complex and leads to non conforming products being delivered to the automotive manufacturer.	Strongly agree	0	0.0%
	Agree	0	0.0%
	Not sure	0	0.0%
	Disagree	3	60.0%
	Strongly disagree	2	40.0%
17. New customer specific requirements are introduced with the intent to develop supplier to a required expected level of quality as part of the automotive manufacturers continual improvement drive.	Strongly agree	1	20.0%
	Agree	3	60.0%
	Not sure	0	0.0%
	Disagree	1	20.0%
	Strongly disagree	0	0.0%
18. The automotive manufacturers ensure that all tier suppliers adhere to customer specific requirements.	Strongly agree	1	20.0%
	Agree	1	20.0%
	Not sure	0	0.0%
	Disagree	3	60.0%
	Strongly disagree	0	0.0%
19. The intent of customer specific requirements is the reduce cost whilst increase productivity from all suppliers.	Strongly agree	1	20.0%
	Agree	1	20.0%
	Not sure	0	0.0%
	Disagree	3	60.0%
	Strongly disagree	0	0.0%
20. It is the responsibility of each supplier to ensure that their suppliers implement	Strongly agree	2	40.0%
	Agree	3	60.0%

Variables	Categories	Frequency	Percentage out of total
customer specific requirements from the automotive manufacturers.	Not sure	0	0.0%
	Disagree	0	0.0%
	Strongly disagree	0	0.0%

TABLE 5. 10: Descriptive statistics for the ordinal variables of OEM's

Variable	N	Mean	Median	Standard Deviation	Range
1. The automotive manufacturer requires the implementation of customer specific requirements to assure quality of the commodity procured from the supplier.	5	1.0	1.0	0.0000	0
2. The automotive manufacturer value the supplier's quality management system.	5	1.2	1.0	0.4472	1
3. The automotive manufacturer has the right to subject the supplier to additional requirements in the form of customer specific requirements.	5	1.4	1.0	0.5477	1
4. The purpose of customer specific requirements is to ensure sustainable quality from suppliers.	5	1.8	2.0	0.4472	1
5. Customer specific requirements add value to the supplier's quality management system.	5	1.6	2.0	0.5477	1
6. Customer specific requirements add value to a supplier's processes.	5	2.0	2.0	1.2247	3
7. Customer specific requirements ensure that the suppliers have clear guidelines in the control and monitoring of their production and service facilities.	5	1.2	1.0	0.4472	1
8. The automotive manufacturer applies the same or similar requirements in their production and assembly facilities.	5	1.4	1.0	0.5477	1
9. Customer specific requirements contribute to mutual beneficial supplier relationships.	5	2.0	2.0	0.0000	0
10. Customer specific requirements and additional requirements like work place improvement and electronic data transfer are introduced with the aim to minimise risk to the automotive	5	1.8	2.0	0.8367	2

manufacturer.					
11. The automotive manufacturer support suppliers with resources and training.	5	1.8	2.0	04472	1
12. The automotive manufacturer train the entire supply chain when changes or additions to customer specific requirements are introduced.	5	2.6	3.0	1.5166	3
13. The automotive manufacturer provides financial support to implements new customer specific requirements to all suppliers.	5	3.4	3.0	1.1402	3
14. Where suppliers have similar activities as specified in customer specific requirements by the automotive manufacturer, the supplier has the right to keep their own standards.	5	2.8	2.0	1.0954	2
15. Generally lower tier suppliers find it difficult to sustain customer specific requirements.	5	3.4	4.0	0.8944	2
16. First tier supplier's quality management systems are complex and leads to non conforming products being delivered to the automotive manufacturer.	5	4.4	4.0	0.5477	1
17. New customer specific requirements are introduced with the intent to develop supplier to a required expected level of quality as part of the automotive manufacturers continual improvement drive.	5	2.2	2.0	10954	3
18. The automotive manufacturers ensure that all tier suppliers adhere to customer specific requirements.	5	3.0	4.0	1.4142	3
19. The intent of customer specific requirements is the reduce cost whilst increase productivity from all suppliers.	5	3.0	4.0	1.4142	3
20. It is the responsibility of each supplier to ensure that their suppliers implement customer specific requirements from the automotive manufacturers.	5	1.6	2.0	0.5477	1

5.3.3 Uni-variate graphs

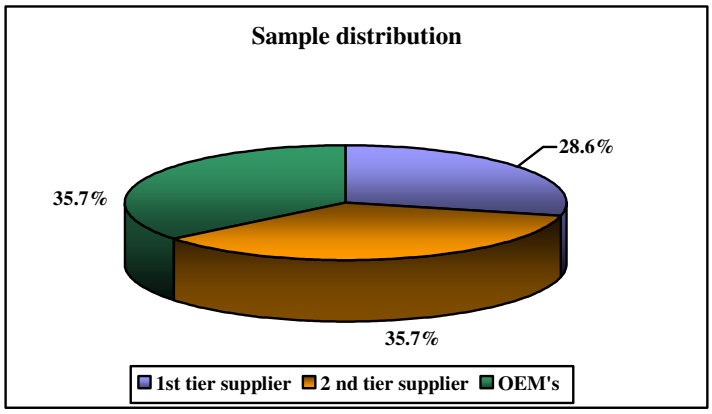

FIGURE 5. 1: Pie with 3D visual effect for the sample distribution

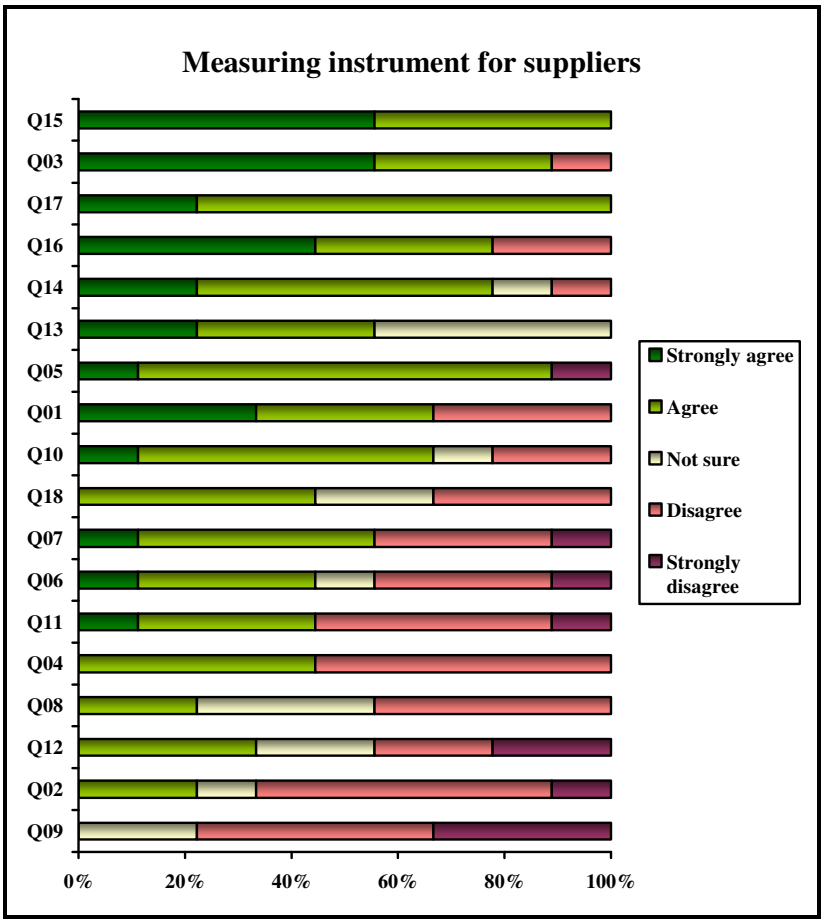

FIGURE 5. 2: 100% stack bar for items in supplier questionnaire

The following statements were scored the most positive:

- It is beneficial and value adding for your organisation to get your suppliers to be compliant to the customer specific requirements from the OEM's (55.6% strongly agree and 44.4% agree).
- To successfully manage multiple and diverse customer specific requirements pose a challenge to ensure buy-in from all employees (55.6% strongly agree and 33.3% agree).
- Your organisation has introduced and sustains all customer specific requirements from the OEM's you deal with (22.2% strongly agree and 77.8% agree).
- Your organisation has its own customer specific requirements that your suppliers must adhere to (44.4% strongly agree and 33.3% agree).
- Your organisation support lower tier suppliers with resources to obtain and maintain your customer specific requirements (22.2% strongly agree and 55.6% agree).
- New customer specific requirements like MMOG/LE and additional customer specific requirements like QSB add value to your processes (11.1% strongly agree and 77.8% agree).
- Request for additional customer specific requirements like QSB from GM and MMOG/LE from Ford creates additional work for you organisation (33.3% strongly agree and 33.3% agree).
- The capability to obtain new business for your organisation is strengthened by implementing all the customer specific requirements from all OEM's (11.1% strongly agree and 55.6% agree).

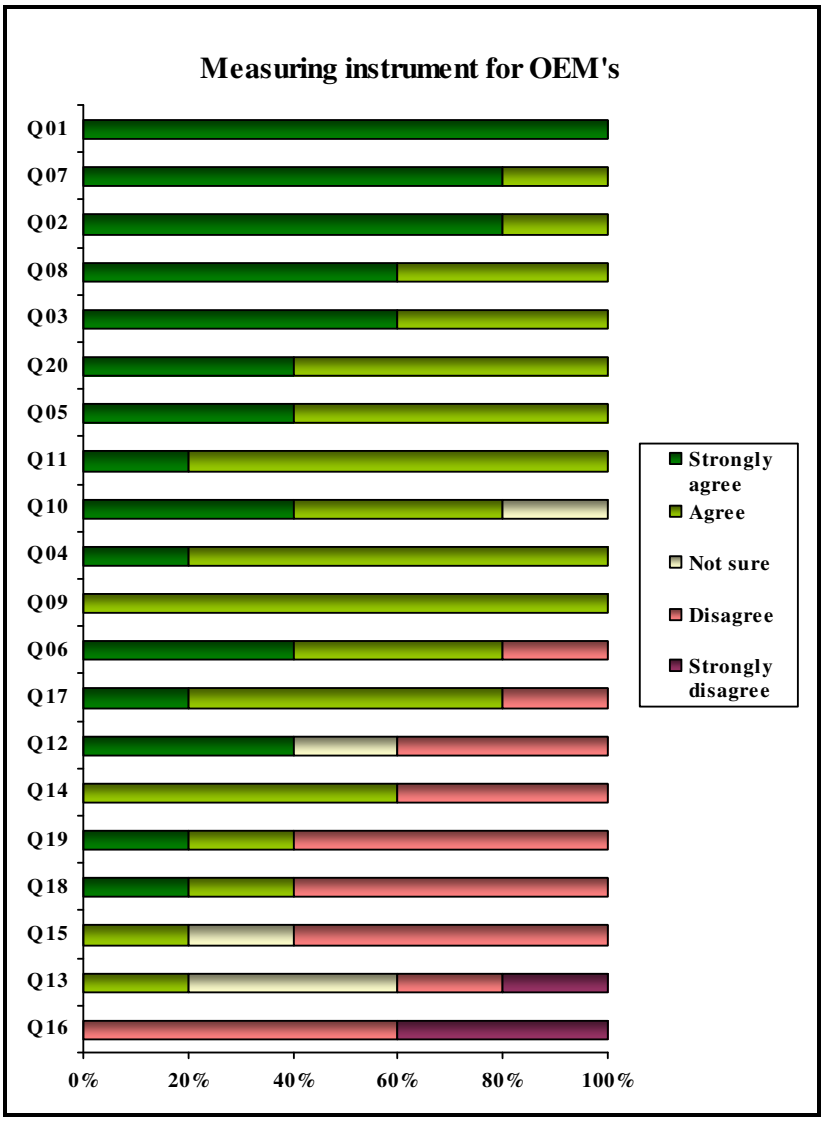

FIGURE 5. 3: 100% stack bar for items in OEM's questionnaire

The following statements were scored the most positive:

- The automotive manufacturer requires the implementation of customer specific requirements to assure the quality of the commodity procured from the supplier (100% strongly agree).
- Customer specific requirements ensure that the suppliers have clear guidelines in the control and monitoring of their products and service facilities (80% strongly agree and 20 % agree)
- The automotive manufacturer value the supplier's quality management system (80% strongly agree and 20 % agree).

- The automotive manufacturer applies the same or similar requirements in their production and assembly facilities (60% strongly agree and 40% agree).
- The automotive manufacturer has the right to subject the supplier to additional requirements in the form of customer specific requirements (60% strongly agree and 40% agree).
- It is the responsibility of each supplier to ensure that their suppliers implement customer specific requirements from the automotive manufacturers (40% strongly agree and 60% agree).
- Customer specific requirements add value to the supplier's quality management system (40% strongly agree and 60% agree).
- The automotive manufacturer support suppliers with resources and training (20% strongly agree and 80% agree).
- The purpose of customer specific requirements is to ensure sustainable quality from suppliers (20% strongly agree and 80 % agree).
- Customer specific requirements contribute to mutual beneficial supplier relationships (100% agree)
- Customer specific requirements and additional requirements like work place improvement and electronic data transfer are introduced with the aim to minimise the risk to the automotive manufacturer (40% strongly agree and 40% agree).

5.3.4 Comparative statistics

The only comparisons that could be made were the comparison between 1st and 2nd tier suppliers to determine whether they agreed in their responses. No comparative statistics were done due to small sample size. The statistically significant results are shown in Table 5.10 and all the rest of the comparisons can be seen in Annexure B as SAS printouts.

TABLE 5. 11: Mann Whitney U test for independent sample comparisons between 1st and 2nd tier suppliers w.r.t. q04

Question / Statement	Sample Size	Chi-Square	DF	P-Value
Comparisons between the 1st and 2nd tier suppliers				
4. Your company's quality management system is susceptible to errors that can lead to non-	9	5.12	1	0.0237*

Question / Statement	Sample Size	Chi-Square	DF	P-Value
conforming conditions when subjected to multiple CSR.				

The 2nd tier suppliers statistically significantly agree more than the 1st tier suppliers that their company's quality management system is susceptible to errors that can lead to non-conforming conditions when subjected to multiple customer specific requirements.

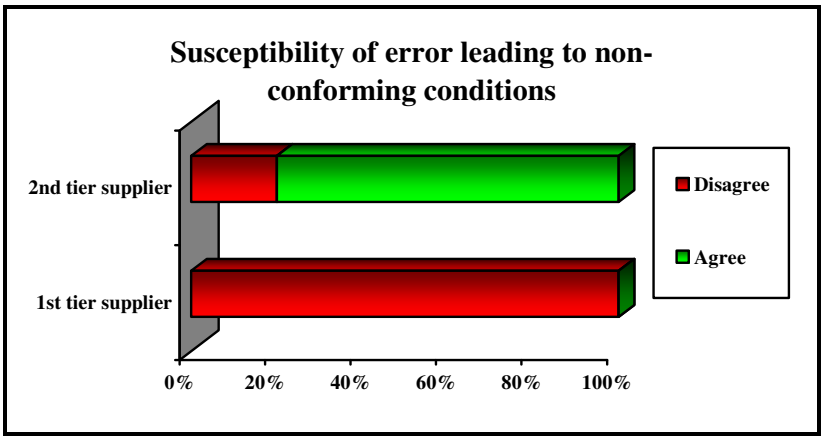

FIGURE 5. 4: 100% stack bar for 1st and 2nd tier comparisons w.r.t. q04.

CHAPTER 6: CONCLUSION

6.1 INTRODUCTION

The research thus far primarily focused on the impact of CSR on the QMS of suppliers and the cost of quality to implement and sustain CSR. The research scope was limited to the Catalytic Converter Industry and specifically the value supply chain amongst the substrate suppliers, the coaters and the canners. The primary objective of the research was to formulate remedial action which could facilitate CSR whilst minimising the impact of supply chain management.

The methodological triangulation as defined served as data collection methodology for this dissertation and was applied and executed accordingly. Second and first tier suppliers were solicited to give their opinions by completing a questionnaire. Interviews were initially planned for all STA's and SQE's representing the OEM's. Only two OEM representatives agreed and participated in an interview. The rest of the OEM representatives agreed to complete and submit the questionnaire. This approach was mainly due to work load and work constrains of the OEM representatives. This however did not influence the outcome of the data collection process. The constrains of the research were the sample size as only the quality representatives of the second and first tier suppliers were available to complete the questionnaire. Notwithstanding, the outcome of the questionnaire yielded meaningful and useful conclusions that could add value to OEM's supplier quality representatives and quality representative for suppliers.

6.2 THE RESEARCH PROBLEM REVISITED

The research problem which has been research within the ambit of this dissertation was defined as follow: "The requirement of the OEM's to demand that customer specific requirements are built into the QMS of a supplier leads to complexity in the supply chain".

The survey results indicated that the 2nd tier suppliers agree more than the 1st tier suppliers that their company's quality management system is susceptible to errors that can lead to non-conforming conditions when subjected to multiple customer

specific requirements. The OEMs however disagreed to the statement, 60 percent disagree whilst 40 percent strongly disagree. According to the survey results, the intent of the OEM's request for CSR is to minimise the shipping, receipt and use of defective products in their process. However this concern results in stringent request for customer specific requirements. The survey results of the first tier suppliers do acknowledge and indicate that their quality management systems are not susceptible to error. The direct interface with the OEM could support to the first tier suppliers comments. As a result, the recommendation to the supply chain is that should be more proactive interaction amongst supply chain members, and a more participative approach is called for from the OEMs through the supply chain. Second and third tier suppliers should invest in more robust quality management systems to minimise the impact of CSR when new business is acquired from OEM's with a stringent CSR. The survey indicated that automotive manufacturers do not necessary ensure that all tier suppliers adhere to customer specific requirements.

6.3 THE RESEARCH QUESTION REVISITED

The research question which has been research within the ambit of this dissertation reads as follow:

"What remedial actions can be formulated, which would facilitate the demand of OEM's for customer specific requirements, while minimising the impact on the supply chain?"

Outputs of the survey concluded the following:

- The OEM does not substitute costs for implementing new customer specific requirements when the new requirements require modifications to the system or processes.
- The flexibility required from the management system, does not make the quality management system effective.
- The OEM does not necessary provide training on customer specific requirements.
- The intent of customer specific requirements is not necessary the reduction of cost whilst the productivity increase from all suppliers.

During the interview with two of the OEM, representatives, they concluded that if an organisation has similar requirements from another OEM it will be acceptable as long as the activity covers their specific needs. As a result, the analogy can be drawn

that suppliers can consolidate multiple CSR from various OEM's as long as compliance is proven. Improved quality throughout the supply chain the OEM should re-evaluate whether the request for CSR positively contributes to sustainable quality through out their supply chains.

6.4 THE INVESTIGATION QUESTION REVISITED

The investigation question in this dissertation has been identified and answered as follow:

- Which areas of the supply chain are most adversely impacted upon as a result of customer specific requirements?

Based on the survey the second tier suppliers are most adversely impacted by multiple CSR. The same dispensation applied to third tier suppliers.

- Can the impact of continual improvement initiatives driven by the OEM`s on lower tier suppliers reduce cost?

Based on the survey results, CSR create more work, with 66 percent of suppliers agreeing culminating in more cost and or resource being required to implement and sustain CSR. From the OEM's perspective, the intent of customer specific requirements is not necessary the reduction of cost, whilst the productivity increase. Therefore it can be accepted that there is no financial gain for lower tiers, but possibly an increase in cost to meet CSR.

- What is the impact of additional requirements on a supplier after the business has been awarded?

According to the survey results, the request for additional customer specific requirements creates additional work for an organisation (33.3% strongly agree and 33.3% agree).

The survey however also found that the capability to obtain new business is strengthened by implementing all the customer specific requirements from all OEM's (11.1% strongly agree and 55.6% agree).

- What impact do compliance and non compliance have on cost and future business allocation?

Based on the survey results, it can be concluded that the majority of the suppliers agree that their opportunity to obtain future business is greater if their organisations implemented the required CSR. (11.1% strongly agree and 55.6% agree).

6.5 KEY RESEARCH OBJECTIVES REVISITED

The key research objectives revisited reads as follow:

- To formulate remedial actions, which would facilitate customer specific requirements while minimising the impact on the supply chain

From the conclusion drawn from the surveys and the interviews conducted the analogy can be drawn that suppliers must take ownership to map their CSR in a matrix. Through this process, suppliers should define the applicable CSR in line with their QMS requirements. Similarities in the various OEM requests should be identified and action items should be defined to meet the most arduous CSR. To improve quality throughputs throughout the supply chain supplier ratings should be initiated to give feedback to customers on agreed topic items.

- To assess the impact of customer specific requirements on QMS's

The survey results point to the fact that CSR creates more work and therefore impact on the QMS. To address this impact, suppliers must assess the robustness of their QMS and identify opportunities to minimize multiple and duplication of activities to meet the OEM's CSR.

- To establish how the cost of quality indicators are affected.

As indicated, the fact that CSR contribute to more "work" for the organisation inevitably means more activity that could impact on cost performance. Cost factors should be reviewed to eliminate duplication of activities that delver similar outputs.

6.6 FINDINGS AND CONCLUSION OF THE RESEARCH SURVEY

The issues that should be addressed with respect to the suppliers are:

- The OEM does not substitute costs for implementing new customer specific requirements, when the new requirements require modifications to the system or processes.
- The flexibility required from the management system, does not make the quality management system effective.
- The OEM does not necessary provide training on customer specific requirements.

The issues that should be addressed with respect to the OEM's are:

- The automotive manufacturers do not necessary ensure that all tier suppliers adhere to customer specific requirements.
- The intent of customer specific requirements is not necessary the reduction of cost whilst the productivity increase from all suppliers.
- The automotive manufacturer does not necessary provide financial support to implement new customer specific requirements to all suppliers.

The 1st and 2nd tier suppliers disagreed with respect to their company's quality management system susceptibility to errors that can lead to non-conforming conditions when subjected to multiple customer specific requirements.

6.7 RECOMMENDATIONS

The following recommendations are made to mitigate the research problem:

- There should be more support from OEM representatives to second and lower tier suppliers to deflect the challenges faced by the suppliers to comply with multiple CSR's.

- Mutual beneficial relations should culminate in partnerships between OEMs and suppliers, rather than a directive approach from the OEM to ensure compliance.

- Lower tier suppliers should insist on more OEM support and involvement to prevent duplication of activities to ensure that each customer specific requirement is met.

- Lower tier suppliers must assess their activities regarding CSR and their QMS to ensure that their QMS is robust instead of meeting the minimum requirements.

- Advance Product Quality Planning (APQP) meetings must be established by supply chain partners, not only at PPAP but also during serial production to ensure that supply related concerns are addressed. These meeting can be on an ad hoc basis when the concerns are identified.

- The OEM should adopt a consultative approach with their supply chain to obtain buy-in from suppliers when improvements are required regarding product quality and service delivery from the supply chain.

- The OEM must ensure that tenders for new business does not force suppliers to offer tenders that will adversely impact the suppliers business when the need for additional CSR are issued to suppliers.

- The cost effectiveness of supplier's tenders should be evaluated to ensure sustainability of supply and service delivery.

- The awarding of tenders should not be based on price alone, but should incorporate infrastructure requirements. As a result CSR should be addressed at the RFQ stage to ensure and assure compliance from potential suppliers.

6.8 FINAL CONCLUSION

During the interviews conducted with representatives from the OEMs, it was suggested that the intention of the OEM is not to force CSR onto suppliers, but rather

to identify the need to conform and therefore reduce poor quality products and services to reach the OEM. It was acknowledged that if the supplier has a stringent QMS and can prove that their QMS meets or has similar activities as the required CSR, that the OEM supplier quality representatives would accept the suppliers system. The survey questionnaires indicated that there are commonalities amongst suppliers to ensure sustainable business by implementing CSR and that the OEM should involve lower tier suppliers to create equity in the supply chain.

It can be concluded that the impact of CSR on supply chain management has significant impact on suppliers. Lower tier suppliers are more susceptible to changes and additional requirements from the OEMs than higher tier suppliers. This can be attributed to the level of interaction between higher tier suppliers and the OEMs in comparison to lower tier suppliers and the OEMs.

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Annexure A :

Descriptive statistics for each variable
1st & 2nd tier suppliers

Q01	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	3	33.33	3	33.33
Agree	3	33.33	6	66.67
Disagree	3	33.33	9	100.00

Chi-Square Test for Equal Proportions

Chi-Square	0.0000
DF	2
Pr > ChiSq	1.0000

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 9

Q02	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree	2	22.22	2	22.22
Not sure	1	11.11	3	33.33
Disagree	5	55.56	8	88.89
Strongly disagree	1	11.11	9	100.00

Chi-Square Test for Equal Proportions

Chi-Square	4.7778
DF	3
Pr > ChiSq	0.1888

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 9

Q03	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	5	55.56	5	55.56
Agree	3	33.33	8	88.89
Disagree	1	11.11	9	100.00

Chi-Square Test for Equal Proportions

Chi-Square	2.6667
DF	2
Pr > ChiSq	0.2636

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 9

Q04	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree	4	44.44	4	44.44
Disagree	5	55.56	9	100.00

Chi-Square Test for Equal Proportions

Chi-Square	0.1111
DF	1
Pr > ChiSq	0.7389

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 9

Q05	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	1	11.11	1	11.11
Agree	7	77.78	8	88.89
Strongly disagree	1	11.11	9	100.00

Chi-Square Test for Equal Proportions

Chi-Square	8.0000
DF	2
Pr > ChiSq	0.0183

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 9

Q06	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	1	11.11	1	11.11
Agree	3	33.33	4	44.44
Not sure	1	11.11	5	55.56
Disagree	3	33.33	8	88.89
Strongly disagree	1	11.11	9	100.00

Chi-Square Test for Equal Proportions

Chi-Square	2.6667
DF	4
Pr > ChiSq	0.6151

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 9

Q07	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	1	11.11	1	11.11

```
Agree                     4       44.44             5        55.56
Disagree                  3       33.33             8        88.89
Strongly disagree         1       11.11             9       100.00

                      Chi-Square Test
                    for Equal Proportions
                    ffffffffffffffffffff
                    Chi-Square     3.0000
                    DF                3
                    Pr > ChiSq     0.3916
        WARNING: The table cells have expected counts less
                 than 5. Chi-Square may not be a valid test.
                      Sample Size = 9

                                                    Cumulative    Cumulative
             Q08    Frequency     Percent     Frequency      Percent
ffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffff
Agree                     2       22.22             2        22.22
Not sure                  3       33.33             5        55.56
Disagree                  4       44.44             9       100.00

                      Chi-Square Test
                    for Equal Proportions
                    ffffffffffffffffffff
                    Chi-Square     0.6667
                    DF                2
                    Pr > ChiSq     0.7165
        WARNING: The table cells have expected counts less
                 than 5. Chi-Square may not be a valid test.
                      Sample Size = 9

                                                    Cumulative    Cumulative
             Q09    Frequency     Percent     Frequency      Percent
ffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffff
Not sure                  2       22.22             2        22.22
Disagree                  4       44.44             6        66.67
Strongly disagree         3       33.33             9       100.00

                      Chi-Square Test
                    for Equal Proportions
                    ffffffffffffffffffff
                    Chi-Square     0.6667
                    DF                2
                    Pr > ChiSq     0.7165
        WARNING: The table cells have expected counts less
                 than 5. Chi-Square may not be a valid test.
                      Sample Size = 9

                                                    Cumulative    Cumulative
             Q10    Frequency     Percent     Frequency      Percent
ffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffff
Strongly agree            1       11.11             1        11.11
Agree                     5       55.56             6        66.67
Not sure                  1       11.11             7        77.78
Disagree                  2       22.22             9       100.00

                      Chi-Square Test
                    for Equal Proportions
                    ffffffffffffffffffff
                    Chi-Square     4.7778
                    DF                3
                    Pr > ChiSq     0.1888
        WARNING: The table cells have expected counts less
                 than 5. Chi-Square may not be a valid test.
                      Sample Size = 9

                                                    Cumulative    Cumulative
             Q11    Frequency     Percent     Frequency      Percent
ffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffff
Strongly agree            1       11.11             1        11.11
Agree                     3       33.33             4        44.44
Disagree                  4       44.44             8        88.89
Strongly disagree         1       11.11             9       100.00

                      Chi-Square Test
                    for Equal Proportions
                    ffffffffffffffffffff
                    Chi-Square     3.0000
                    DF                3
                    Pr > ChiSq     0.3916
        WARNING: The table cells have expected counts less
                 than 5. Chi-Square may not be a valid test.
                      Sample Size = 9

                                                    Cumulative    Cumulative
             Q12    Frequency     Percent     Frequency      Percent
ffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffff
Agree                     3       33.33             3        33.33
Not sure                  2       22.22             5        55.56
Disagree                  2       22.22             7        77.78
Strongly disagree         2       22.22             9       100.00

                      Chi-Square Test
                    for Equal Proportions
                    ffffffffffffffffffff
                    Chi-Square     0.3333
                    DF                3
                    Pr > ChiSq     0.9536
        WARNING: The table cells have expected counts less
                 than 5. Chi-Square may not be a valid test.
                      Sample Size = 9

                                                    Cumulative    Cumulative
             Q13    Frequency     Percent     Frequency      Percent
ffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffff
Strongly agree            2       22.22             2        22.22
Agree                     3       33.33             5        55.56
Not sure                  4       44.44             9       100.00

                      Chi-Square Test
                    for Equal Proportions
                    ffffffffffffffffffff
                    Chi-Square     0.6667
                    DF                2
                    Pr > ChiSq     0.7165
        WARNING: The table cells have expected counts less
```

than 5. Chi-Square may not be a valid test.
Sample Size = 9

Q14	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	2	22.22	2	22.22
Agree	5	55.56	7	77.78
Not sure	1	11.11	8	88.89
Disagree	1	11.11	9	100.00

Chi-Square Test for Equal Proportions

Chi-Square	4.7778
DF	3
Pr > ChiSq	0.1888

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 9

Q15	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	5	55.56	5	55.56
Agree	4	44.44	9	100.00

Chi-Square Test for Equal Proportions

Chi-Square	0.1111
DF	1
Pr > ChiSq	0.7389

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 9

Q16	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	4	44.44	4	44.44
Agree	3	33.33	7	77.78
Disagree	2	22.22	9	100.00

Chi-Square Test for Equal Proportions

Chi-Square	0.6667
DF	2
Pr > ChiSq	0.7165

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 9

Q17	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	2	22.22	2	22.22
Agree	7	77.78	9	100.00

Chi-Square Test for Equal Proportions

Chi-Square	2.7778
DF	1
Pr > ChiSq	0.0956

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 9

Q18	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree	4	44.44	4	44.44
Not sure	2	22.22	6	66.67
Disagree	3	33.33	9	100.00

Chi-Square Test for Equal Proportions

Chi-Square	0.6667
DF	2
Pr > ChiSq	0.7165

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 9

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
Q01	9	2.33333	1.32288	21.00000	1.00000	4.00000	
Q02	9	3.55556	1.01379	32.00000	2.00000	5.00000	
Q03	9	1.66667	1.00000	15.00000	1.00000	4.00000	
Q04	9	3.11111	1.05409	28.00000	2.00000	4.00000	
Q05	9	2.22222	1.09291	20.00000	1.00000	5.00000	
Q06	9	3.00000	1.32288	27.00000	1.00000	5.00000	
Q07	9	2.88889	1.36423	26.00000	1.00000	5.00000	
Q08	9	3.22222	0.83333	29.00000	2.00000	4.00000	
Q09	9	4.11111	0.78174	37.00000	3.00000	5.00000	
Q10	9	2.44444	1.01379	22.00000	1.00000	4.00000	
Q11	9	3.11111	1.36423	28.00000	1.00000	5.00000	

Q12	Q12	9	3.33333	1.22474	30.00000	2.00000	5.00000
Q13	Q13	9	2.22222	0.83333	20.00000	1.00000	3.00000
Q14	Q14	9	2.11111	0.92796	19.00000	1.00000	4.00000
Q15	Q15	9	1.44444	0.52705	13.00000	1.00000	2.00000
Q16	Q16	9	2.00000	1.22474	18.00000	1.00000	4.00000
Q17	Q17	9	1.77778	0.44096	16.00000	1.00000	2.00000
Q18	Q18	9	2.88889	0.92796	26.00000	2.00000	4.00000

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.551500
Standardized	0.584986

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables Correlation with Total	Raw Variables Alpha	Standardized Variables Correlation with Total	Standardized Variables Alpha	Label
Q01	0.182193	0.539311	0.238246	0.565588	Q01
Q02	0.383391	0.503071	0.352692	0.547112	Q02
Q03	0.295772	0.518783	0.317590	0.552849	Q03
Q04	-.134186	0.590278	-.202105	0.630762	Q04
Q05	0.046539	0.561928	0.024893	0.598308	Q05
Q06	-.044666	0.586940	-.083256	0.614066	Q06
Q07	0.159482	0.544892	0.170509	0.576215	Q07
Q08	0.282321	0.524595	0.362029	0.545575	Q08
Q09	0.223343	0.533550	0.129001	0.582617	Q09
Q10	0.505640	0.480839	0.523990	0.518206	Q10
Q11	0.257213	0.522459	0.274123	0.559866	Q11
Q12	0.415098	0.488977	0.345561	0.548282	Q12
Q13	0.307775	0.521003	0.370379	0.544197	Q13
Q14	-.028136	0.569274	0.070080	0.591561	Q14
Q15	0.748447	0.490948	0.684318	0.489749	Q15
Q16	0.291091	0.515882	0.410961	0.537450	Q16
Q17	-.073339	0.561119	-.066686	0.611687	Q17
Q18	-.113465	0.581408	-.101276	0.616639	Q18

Cronbach Coefficient Alpha for first group of items

Variables	Alpha
Raw	0.785714
Standardized	0.796720

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables Correlation with Total	Raw Variables Alpha	Standardized Variables Correlation with Total	Standardized Variables Alpha	Label
Q01	0.554324	0.755166	0.533414	0.772237	Q01
Q02	0.350573	0.779087	0.296406	0.796984	Q02
Q03	0.706439	0.737945	0.658539	0.758427	Q03
Q08	0.297940	0.782788	0.355588	0.790974	Q08
Q10	0.560564	0.755114	0.557855	0.769581	Q10
Q11	0.349561	0.786954	0.318322	0.794771	Q11
Q13	0.433555	0.770445	0.476492	0.778347	Q13
Q14	0.163409	0.796761	0.240573	0.802553	Q14
Q15	0.408184	0.776903	0.381831	0.788273	Q15
Q16	0.721937	0.729836	0.764930	0.746268	Q16
Q17	0.487298	0.775072	0.440827	0.782121	Q17

Cronbach Coefficient Alpha for second group of items

Variables	Alpha
Raw	0.803306
Standardized	0.797104

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables Correlation with Total	Raw Variables Alpha	Standardized Variables Correlation with Total	Standardized Variables Alpha	Label
Q05	0.664371	0.749578	0.617264	0.750201	Q05
Q06	0.814613	0.703125	0.774347	0.711054	Q06
Q07	0.656793	0.749530	0.618812	0.749828	Q07
Q09	0.872656	0.730676	0.902421	0.677097	Q09
Q12	0.726395	0.730699	0.738343	0.720266	Q12
Q18	-.202481	0.897508	-.153242	0.906165	Q18

Descriptive statistics for each variable
OEM's

Q01	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	5	100.00	5	100.00

Chi-Square Test for Equal Proportions

Chi-Square	0.0000
DF	0
Pr > ChiSq	.

Sample Size = 5

Q02	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	4	80.00	4	80.00
Agree	1	20.00	5	100.00

Chi-Square Test for Equal Proportions

Chi-Square	1.8000
DF	1
Pr > ChiSq	0.1797

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 5

Q03	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	3	60.00	3	60.00
Agree	2	40.00	5	100.00

Chi-Square Test for Equal Proportions

Chi-Square	0.2000
DF	1
Pr > ChiSq	0.6547

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 5

Q04	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	1	20.00	1	20.00
Agree	4	80.00	5	100.00

Chi-Square Test for Equal Proportions

Chi-Square	1.8000
DF	1
Pr > ChiSq	0.1797

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 5

Q05	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	2	40.00	2	40.00
Agree	3	60.00	5	100.00

Chi-Square Test for Equal Proportions

Chi-Square	0.2000
DF	1
Pr > ChiSq	0.6547

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 5

Q06	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	2	40.00	2	40.00
Agree	2	40.00	4	80.00
Disagree	1	20.00	5	100.00

Chi-Square Test for Equal Proportions

Chi-Square	0.4000
DF	2
Pr > ChiSq	0.8187

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 5

Q07	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	4	80.00	4	80.00
Agree	1	20.00	5	100.00

Chi-Square Test for Equal Proportions

Chi-Square	1.8000
DF	1
Pr > ChiSq	0.1797

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 5

Q08	Frequency	Percent	Cumulative Frequency	Cumulative Percent

Strongly agree	3	60.00	3	60.00
Agree	2	40.00	5	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	0.2000
DF	1
Pr > ChiSq	0.6547

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 5

Q09	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree	5	100.00	5	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	0.0000
DF	0
Pr > ChiSq	.

Sample Size = 5

Q10	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	2	40.00	2	40.00
Agree	2	40.00	4	80.00
Not sure	1	20.00	5	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	0.4000
DF	2
Pr > ChiSq	0.8187

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 5

Q11	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	1	20.00	1	20.00
Agree	4	80.00	5	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	1.8000
DF	1
Pr > ChiSq	0.1797

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 5

Q12	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	2	40.00	2	40.00
Not sure	1	20.00	3	60.00
Disagree	2	40.00	5	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	0.4000
DF	2
Pr > ChiSq	0.8187

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 5

Q13	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree	1	20.00	1	20.00
Not sure	2	40.00	3	60.00
Disagree	1	20.00	4	80.00
Strongly disagree	1	20.00	5	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	0.6000
DF	3
Pr > ChiSq	0.8964

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 5

Q14	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree	3	60.00	3	60.00
Disagree	2	40.00	5	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	0.2000
DF	1
Pr > ChiSq	0.6547

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 5

Q15	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree	1	20.00	1	20.00
Not sure	1	20.00	2	40.00

```
Disagree                    3       60.00             5       100.00


                        Chi-Square Test
                      for Equal Proportions
                      ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                      Chi-Square     1.6000
                      DF                2
                      Pr > ChiSq     0.4493
          WARNING: The table cells have expected counts less
                   than 5. Chi-Square may not be a valid test.
                        Sample Size = 5

                                                  Cumulative    Cumulative
              Q16    Frequency     Percent     Frequency      Percent
ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
Disagree                    3       60.00             3        60.00
Strongly disagree           2       40.00             5       100.00

                        Chi-Square Test
                      for Equal Proportions
                      ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                      Chi-Square     0.2000
                      DF                1
                      Pr > ChiSq     0.6547
          WARNING: The table cells have expected counts less
                   than 5. Chi-Square may not be a valid test.
                        Sample Size = 5

                                                  Cumulative    Cumulative
              Q17    Frequency     Percent     Frequency      Percent
ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
Strongly agree              1       20.00             1        20.00
Agree                       3       60.00             4        80.00
Disagree                    1       20.00             5       100.00

                        Chi-Square Test
                      for Equal Proportions
                      ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                      Chi-Square     1.6000
                      DF                2
                      Pr > ChiSq     0.4493
          WARNING: The table cells have expected counts less
                   than 5. Chi-Square may not be a valid test.
                        Sample Size = 5

                                                  Cumulative    Cumulative
              Q18    Frequency     Percent     Frequency      Percent
ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
Strongly agree              1       20.00             1        20.00
Agree                       1       20.00             2        40.00
Disagree                    3       60.00             5       100.00

                        Chi-Square Test
                      for Equal Proportions
                      ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                      Chi-Square     1.6000
                      DF                2
                      Pr > ChiSq     0.4493
          WARNING: The table cells have expected counts less
                   than 5. Chi-Square may not be a valid test.
                        Sample Size = 5

                                                  Cumulative    Cumulative
              Q19    Frequency     Percent     Frequency      Percent
ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
Strongly agree              1       20.00             1        20.00
Agree                       1       20.00             2        40.00
Disagree                    3       60.00             5       100.00

                        Chi-Square Test
                      for Equal Proportions
                      ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                      Chi-Square     1.6000
                      DF                2
                      Pr > ChiSq     0.4493
          WARNING: The table cells have expected counts less
                   than 5. Chi-Square may not be a valid test.
                        Sample Size = 5

                                                  Cumulative    Cumulative
              Q20    Frequency     Percent     Frequency      Percent
ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
Strongly agree              2       40.00             2        40.00
Agree                       3       60.00             5       100.00

                        Chi-Square Test
                      for Equal Proportions
                      ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                      Chi-Square     0.2000
                      DF                1
                      Pr > ChiSq     0.6547
          WARNING: The table cells have expected counts less
                   than 5. Chi-Square may not be a valid test.
                        Sample Size = 5
```

Cronbach Coefficient Alpha for first group of items

Variables	Alpha
Raw	0.804233
Standardized	0.801789

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables: Correlation with Total	Raw Variables: Alpha	Standardized Variables: Correlation with Total	Standardized Variables: Alpha	Label
Q04	0.878930	0.773438	0.957309	0.724676	Q04
Q05	0.320427	0.802474	0.527459	0.778474	Q05
Q06	0.547399	0.780319	0.317367	0.802199	Q06
Q07	0.223792	0.808361	0.287300	0.805462	Q07
Q08	-.016317	0.823083	0.259297	0.808473	Q08
Q12	0.790789	0.742021	0.560903	0.774546	Q12
Q13	0.733623	0.751682	0.566372	0.773900	Q13
Q16	0.065795	0.818182	0.123405	0.822694	Q16
Q18	0.958333	0.706250	0.829260	0.741468	Q18
Q20	0.320427	0.802474	0.429997	0.789682	Q20

Cronbach Coefficient Alpha for second group of items

Variables	Alpha
Raw	0.771288
Standardized	0.757438

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables: Correlation with Total	Raw Variables: Alpha	Standardized Variables: Correlation with Total	Standardized Variables: Alpha	Label
Q02	0.075378	0.789562	0.049894	0.799644	Q02
Q03	0.274430	0.773619	0.263576	0.765241	Q03
Q10	0.674453	0.713816	0.756597	0.673612	Q10
Q11	0.637793	0.744821	0.629091	0.699036	Q11
Q14	0.523810	0.738095	0.411408	0.739621	Q14
Q15	0.103418	0.804813	0.037676	0.801521	Q15
Q17	0.884985	0.654472	0.887369	0.646219	Q17
Q19	0.736231	0.691740	0.761806	0.672547	Q19

Annexure B :

Inferential statistics

Wilcoxon Scores (Rank Sums) for Variable QO1

Supplier	N	Sum of Scores	Expected Under HO	Std Dev Under HO	Mean Score
1 st Tier Supplier	4	23.0	20.0	3.872983	5.750
2 nd Tier Supplier	5	22.0	25.0	3.872983	4.400

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic	23.0000
Normal Approximation	
Z	0.6455
One-Sided Pr > Z	0.2593
Two-Sided Pr > |Z|	0.5186
t Approximation	
One-Sided Pr > Z	0.2683
Two-Sided Pr > |Z|	0.5367

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.6000
DF	1
Pr > Chi-Square	0.4386

Wilcoxon Scores (Rank Sums) for Variable QO2

Supplier	N	Sum of Scores	Expected Under HO	Std Dev Under HO	Mean Score
1 st Tier Supplier	4	19.50	20.0	3.708099	4.8750
2 nd Tier Supplier	5	25.50	25.0	3.708099	5.1000

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic	19.5000
Normal Approximation	
Z	0.0000
One-Sided Pr < Z	0.5000
Two-Sided Pr > |Z|	1.0000
t Approximation	
One-Sided Pr < Z	0.5000
Two-Sided Pr > |Z|	1.0000

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.0182
DF	1
Pr > Chi-Square	0.8927

Wilcoxon Scores (Rank Sums) for Variable QO3

Supplier	N	Sum of Scores	Expected Under HO	Std Dev Under HO	Mean Score
1 st Tier Supplier	4	20.0	20.0	3.651484	5.0
2 nd Tier Supplier	5	25.0	25.0	3.651484	5.0

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic	20.0000
Normal Approximation	
Z	0.0000
One-Sided Pr < Z	0.5000
Two-Sided Pr > |Z|	1.0000
t Approximation	
One-Sided Pr < Z	0.5000
Two-Sided Pr > |Z|	1.0000

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.0000
DF	1
Pr > Chi-Square	1.0000

Wilcoxon Scores (Rank Sums) for Variable QO4

Supplier	N	Sum of Scores	Expected Under HO	Std Dev Under HO	Mean Score
1 st Tier Supplier	4	28.0	20.0	3.535534	7.00
2 nd Tier Supplier	5	17.0	25.0	3.535534	3.40

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic	28.0000
Normal Approximation	
Z	2.1213
One-Sided Pr > Z	0.0169
Two-Sided Pr > |Z|	0.0339
t Approximation	
One-Sided Pr > Z	0.0333
Two-Sided Pr > |Z|	0.0667

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	5.1200
DF	1
Pr > Chi-Square	0.0237

Wilcoxon Scores (Rank Sums) for Variable QO5
Classified by Variable Supplier

Supplier	N	Sum of Scores	Expected Under HO	Std Dev Under HO	Mean Score
1 st Tier Supplier	4	16.0	20.0	2.981424	4.00
2 nd Tier Supplier	5	29.0	25.0	2.981424	5.80

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic	16.0000
Normal Approximation	
Z	-1.1739
One-Sided Pr < Z	0.1202

Two-Sided Pr > |Z|	0.2404
t Approximation	
One-Sided Pr < Z	0.1371
Two-Sided Pr > |Z|	0.2742

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test	
Chi-Square	1.8000
DF	1
Pr > Chi-Square	0.1797

Wilcoxon Scores (Rank Sums) for Variable QO6

Supplier	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
1 st Tier Supplier	4	20.0	20.0	3.944053	5.0
2 nd Tier Supplier	5	25.0	25.0	3.944053	5.0

Average scores were used for ties.

Wilcoxon Two-Sample Test	
Statistic	20.0000
Normal Approximation	
Z	0.0000
One-Sided Pr < Z	0.5000
Two-Sided Pr > |Z|	1.0000
t Approximation	
One-Sided Pr < Z	0.5000
Two-Sided Pr > |Z|	1.0000

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test	
Chi-Square	0.0000
DF	1
Pr > Chi-Square	1.0000

Wilcoxon Scores (Rank Sums) for Variable QO7

Supplier	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
1 st Tier Supplier	4	18.50	20.0	3.836955	4.6250
2 nd Tier Supplier	5	26.50	25.0	3.836955	5.3000

Average scores were used for ties.

Wilcoxon Two-Sample Test	
Statistic	18.5000
Normal Approximation	
Z	-0.2606
One-Sided Pr < Z	0.3972
Two-Sided Pr > |Z|	0.7944
t Approximation	
One-Sided Pr < Z	0.4005
Two-Sided Pr > |Z|	0.8010

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test	
Chi-Square	0.1528
DF	1
Pr > Chi-Square	0.6958

Wilcoxon Scores (Rank Sums) for Variable QO8

Supplier	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
1 st Tier Supplier	4	14.50	20.0	3.818813	3.6250
2 nd Tier Supplier	5	30.50	25.0	3.818813	6.1000

Average scores were used for ties.

Wilcoxon Two-Sample Test	
Statistic	14.5000
Normal Approximation	
Z	-1.3093
One-Sided Pr < Z	0.0952
Two-Sided Pr > |Z|	0.1904
t Approximation	
One-Sided Pr < Z	0.1134
Two-Sided Pr > |Z|	0.2268

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test	
Chi-Square	2.0743
DF	1
Pr > Chi-Square	0.1498

Wilcoxon Scores (Rank Sums) for Variable QO9

Supplier	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
1 st Tier Supplier	4	22.0	20.0	3.818813	5.50
2 nd Tier Supplier	5	23.0	25.0	3.818813	4.60

Average scores were used for ties.

Wilcoxon Two-Sample Test	
Statistic	22.0000
Normal Approximation	
Z	0.3928
One-Sided Pr > Z	0.3472
Two-Sided Pr > |Z|	0.6945
t Approximation	
One-Sided Pr > Z	0.3524
Two-Sided Pr > |Z|	0.7047

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test	
Chi-Square	0.2743
DF	1
Pr > Chi-Square	0.6005

Wilcoxon Scores (Rank Sums) for Variable Q10

Supplier	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
1 st Tier Supplier	4	20.50	20.0	3.708099	5.1250
2 nd Tier Supplier	5	24.50	25.0	3.708099	4.9000

Average scores were used for ties.

```
                          Wilcoxon Two-Sample Test
                        Statistic            20.5000
                        Normal Approximation
                        Z                     0.0000
                        One-Sided Pr <  Z     0.5000
                        Two-Sided Pr > |Z|    1.0000
                        t Approximation
                        One-Sided Pr <  Z     0.5000
                        Two-Sided Pr > |Z|    1.0000
                   Z includes a continuity correction of 0.5.

                             Kruskal-Wallis Test
                        Chi-Square            0.0182
                        DF                         1
                        Pr > Chi-Square       0.8927

                  Wilcoxon Scores (Rank Sums) for Variable Q11
                                 Sum of      Expected       Std Dev          Mean
Supplier               N        Scores      Under H0      Under H0         Score
ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
1 st Tier Supplier     4          25.0          20.0      3.836955         6.250
2 nd Tier Supplier     5          20.0          25.0      3.836955         4.000
                        Average scores were used for ties.

                          Wilcoxon Two-Sample Test
                        Statistic            25.0000
                        Normal Approximation
                        Z                     1.1728
                        One-Sided Pr >  Z     0.1204
                        Two-Sided Pr > |Z|    0.2409
                        t Approximation
                        One-Sided Pr >  Z     0.1373
                        Two-Sided Pr > |Z|    0.2746
                   Z includes a continuity correction of 0.5.

                             Kruskal-Wallis Test
                        Chi-Square            1.6981
                        DF                         1
                        Pr > Chi-Square       0.1925

                  Wilcoxon Scores (Rank Sums) for Variable Q12
                                 Sum of      Expected       Std Dev          Mean
Supplier               N        Scores      Under H0      Under H0         Score
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1 st Tier Supplier     4          19.0          20.0      3.961621         4.750
2 nd Tier Supplier     5          26.0          25.0      3.961621         5.200
                        Average scores were used for ties.

                          Wilcoxon Two-Sample Test
                        Statistic            19.0000
                        Normal Approximation
                        Z                    -0.1262
                        One-Sided Pr <  Z     0.4498
                        Two-Sided Pr > |Z|    0.8996
                        t Approximation
                        One-Sided Pr <  Z     0.4513
                        Two-Sided Pr > |Z|    0.9027
                   Z includes a continuity correction of 0.5.

                             Kruskal-Wallis Test
                        Chi-Square            0.0637
                        DF                         1
                        Pr > Chi-Square       0.8007

                  Wilcoxon Scores (Rank Sums) for Variable Q13
                                 Sum of      Expected       Std Dev          Mean
Supplier               N        Scores      Under H0      Under H0         Score
ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
1 st Tier Supplier     4          11.0          20.0      3.818813         2.750
2 nd Tier Supplier     5          34.0          25.0      3.818813         6.800
                        Average scores were used for ties.

                          Wilcoxon Two-Sample Test
                        Statistic            11.0000
                        Normal Approximation
                        Z                    -2.2258
                        One-Sided Pr <  Z     0.0130
                        Two-Sided Pr > |Z|    0.0260
                        t Approximation
                        One-Sided Pr <  Z     0.0283
                        Two-Sided Pr > |Z|    0.0567

                   Z includes a continuity correction of 0.5.

                             Kruskal-Wallis Test
                        Chi-Square            5.5543
                        DF                         1
                        Pr > Chi-Square       0.0184

                  Wilcoxon Scores (Rank Sums) for Variable Q14
                                 Sum of      Expected       Std Dev          Mean
Supplier               N        Scores      Under H0      Under H0         Score
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1 st Tier Supplier     4          13.0          20.0      3.708099         3.250
2 nd Tier Supplier     5          32.0          25.0      3.708099         6.400
                        Average scores were used for ties.

                          Wilcoxon Two-Sample Test
                        Statistic            13.0000
                        Normal Approximation
                        Z                    -1.7529
                        One-Sided Pr <  Z     0.0398
                        Two-Sided Pr > |Z|    0.0796
                        t Approximation
                        One-Sided Pr <  Z     0.0589
                        Two-Sided Pr > |Z|    0.1177
                   Z includes a continuity correction of 0.5.

                             Kruskal-Wallis Test
                        Chi-Square            3.5636
                        DF                         1
                        Pr > Chi-Square       0.0591

                  Wilcoxon Scores (Rank Sums) for Variable Q15
                                 Sum of      Expected       Std Dev          Mean
Supplier               N        Scores      Under H0      Under H0         Score
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1 st Tier Supplier       4         16.50          20.0      3.535534        4.1250
2 nd Tier Supplier       5         28.50          25.0      3.535534        5.7000
                      Average scores were used for ties.

                         Wilcoxon Two-Sample Test
                         Statistic              16.5000
                         Normal Approximation
                         Z                      -0.8485
                         One-Sided Pr <  Z       0.1981
                         Two-Sided Pr > |Z|      0.3961
                         t Approximation
                         One-Sided Pr <  Z       0.2104
                         Two-Sided Pr > |Z|      0.4208
                   Z includes a continuity correction of 0.5.

                              Kruskal-Wallis Test
                         Chi-Square              0.9800
                         DF                           1
                         Pr > Chi-Square         0.3222

                   Wilcoxon Scores (Rank Sums) for Variable Q16
                                 Sum of      Expected       Std Dev          Mean
Supplier                 N       Scores      Under H0      Under H0         Score
ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
1 st Tier Supplier       4         13.50          20.0      3.818813        3.3750
2 nd Tier Supplier       5         31.50          25.0      3.818813        6.3000
                      Average scores were used for ties.

                         Wilcoxon Two-Sample Test
                         Statistic              13.5000
                         Normal Approximation
                         Z                      -1.5712
                         One-Sided Pr <  Z       0.0581
                         Two-Sided Pr > |Z|      0.1161
                         t Approximation
                         One-Sided Pr <  Z       0.0774
                         Two-Sided Pr > |Z|      0.1548
                   Z includes a continuity correction of 0.5.

                              Kruskal-Wallis Test
                         Chi-Square              2.8971
                         DF                           1
                         Pr > Chi-Square         0.0887

                   Wilcoxon Scores (Rank Sums) for Variable Q17
                                 Sum of      Expected       Std Dev          Mean
Supplier                 N       Scores      Under H0      Under H0         Score
ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
1 st Tier Supplier       4         19.50          20.0      2.958040        4.8750
2 nd Tier Supplier       5         25.50          25.0      2.958040        5.1000
                      Average scores were used for ties.

                         Wilcoxon Two-Sample Test
                         Statistic              19.5000
                         Normal Approximation
                         Z                       0.0000
                         One-Sided Pr <  Z       0.5000
                         Two-Sided Pr > |Z|      1.0000
                         t Approximation
                         One-Sided Pr <  Z       0.5000
                         Two-Sided Pr > |Z|      1.0000
                   Z includes a continuity correction of 0.5.

                              Kruskal-Wallis Test
                         Chi-Square              0.0286
                         DF                           1
                         Pr > Chi-Square         0.8658

                   Wilcoxon Scores (Rank Sums) for Variable Q18
                                 Sum of      Expected       Std Dev          Mean
Supplier                 N       Scores      Under H0      Under H0         Score
ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
1 st Tier Supplier       4          24.0           20.0      3.818813          6.00
2 nd Tier Supplier       5          21.0           25.0      3.818813          4.20
                      Average scores were used for ties.

                         Wilcoxon Two-Sample Test
                         Statistic              24.0000
                         Normal Approximation
                         Z                       0.9165
                         One-Sided Pr >  Z       0.1797
                         Two-Sided Pr > |Z|      0.3594
                         t Approximation
                         One-Sided Pr >  Z       0.1931
                         Two-Sided Pr > |Z|      0.3862
                   Z includes a continuity correction of 0.5.

                              Kruskal-Wallis Test
                         Chi-Square              1.0971
                         DF                           1
```